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THE STUDY OF THE STARS[1]

THE object of the American Association is the advancement of science. This is a very different matter from the diffusion of human knowledge. The universities and colleges provide liberally for the latter subject, but neglect the former almost entirely. Science is advanced by many individuals who hold offices in the universities, but seldom as a part of their official duties. Few professors are allowed to regard research as a portion of their college work, and still less frequently are appropriations made or funds provided for original investigation. Astronomy is almost the only exception to this rule, and even here in general, the time of the officers is mainly devoted to teaching. Observatories devoted to research like McCormick, Lick and Harvard are supported by funds given specifically for their use, and receive little, or no aid, from the general funds of the universities with which they are associated. It is probable that American universities devote one hundred times as much money to the diffusion of human knowledge, as to its advancement. The great progress made in America in some departments of astronomy is due to the fact that certain wealthy men and women have been willing to give large sums of money for this object. No other country is so fortunate in this respect, although in recent years in Germany large appropriations are being made by the government for similar purposes.

The income of certain funds like the Elizabeth Thompson, Bache and Watson

[1] Address of the President of the American Association for the Advancement of Science, Atlanta, December 29, 1913.

funds is also available, but while these are of the greatest value in aiding particular individuals, the amount is too small to materially advance the entire science. The large funds which might aid individual research are unfortunately employed for other purposes. Scarcely any appropriations have been made to women from these funds. One of the greatest needs of science in America is a fund of moderate size, capable of aiding the men of real genius. The number of such men is not large, and a judicious distribution of a few thousand dollars annually would probably yield greater results than could be obtained in any other way.

A visit to Europe last summer in order to attend the meetings of two national and two international astronomical societies, enabled me to visit several of the larger observatories and to interchange views with the leading astronomers of the world. I have accordingly selected as my subject for this evening "The Study of the Stars," and I shall endeavor to transmit to you the latest views as well as the history of this department of human knowledge. It is my wish to present to my professional friends certain facts of a technical nature, and at the same time to make these clear to those of my hearers who have no previous knowledge of the subject. Astronomy has been called not only the oldest of the sciences but that which has conferred the greatest benefits on man by rendering international commerce possible. While this may be true of the past, the value of the astronomy of the present day lies in its extension of human knowledge and enabling the mind of man to traverse fields which until recently appeared to be hopelessly beyond his ken.

The first catalogue of the stars was made by Hipparchus about B.C. 128, and was inserted by Ptolemy in the "Almagest," for fourteen centuries the authority in astronomy for the world. This catalogue, which contained more than a thousand stars, gave both their positions and brightness. The earliest copy that is known of the "Almagest" is in the Bibliothèque National in Paris. It is a beautiful manuscript in uncial characters of the ninth century. The other later manuscripts unfortunately differ from it and from each other, so that there is some uncertainty regarding two thirds of the stars, owing to errors of copying. A careful study of these discrepancies has been made by Dr. Peters, of Clinton, and Mr. Knobel, of London. Each spent several years on this work, and all the papers are in the hands of Mr. Knobel. He is now preparing the entire work for publication and it is hoped that it will be in the hands of the printer in a few months.

A manuscript of nearly the same age is in the library of the Vatican, and this year a revised edition of it has been published. If we had a correct copy of the original work, it would have a great value at the present time. Half a century ago it would probably have given the best existing values of the proper motions of the stars which it contained, but recent observations enable us to compute their positions in the time of Hipparchus, more accurately than he could observe them, assuming that the motion was rectilinear. This work might, however, throw light on a possible curvature of the motions. The observations by Hipparchus of the light of the stars have a value that will be considered later.

The first accurate measures of the positions of the stars were made in the middle of the eighteenth century. The catalogue of Bradley in 1755 is even at the present time one of the best means of determining the early positions of the stars. A large number of similar, but later, observations by Hornsby are still unpublished. During

the next hundred years the meridian circle, which is at present the standard instrument for determining the places of the stars, was gradually evolved. In this instrument, a telescope is mounted so that it will point only to stars in the meridian, that is, to stars exactly north or south of the observer. The declinations of stars, corresponding to the latitude of points on the surface of the earth, are then measured by a finely graduated circle. Owing to the motion of the earth all stars cross the meridian twice during every twenty-four hours. The right ascension, corresponding to longitude, will be given by the time of transit. At first, this time was found by the "eye and ear" method in which the observer counted the ticks of an accurate timepiece and compared them mentally with the instant at which the star appeared to cross a wire in the field of view of the telescope. About the middle of the nineteenth century a great advance was made by recording the time electrically on a chronograph. This method was known for many years as the "American" method, owing to its introduction and general adoption in this country. This continued to be the standard method almost to the present time, and an enormous number of observations have been accumulated in this way, the total cost amounting to millions of dollars. Perhaps the most valuable work of this kind is that of the Astronomische Gesellschaft, which, by international cooperation, secured accurate observations of the positions of one hundred and sixty-six thousand stars. All stars of the ninth magnitude, and brighter, north of declination —23° are included. Of the twenty zones, seven were observed in Germany, four in the United States, three in Russia, one each in Algeria, Austria, England, Holland, Norway and Sweden. Of the American zones, one was observed at Albany, one at Washington, and two at Cambridge. Each of the latter occupied the time of an observer and several assistants for twenty years. It was expected that these stars would be re-observed after an interval of about fifty years, to determine the proper motions, or annual changes in position. As the time is approaching when this great work should be undertaken, careful consideration should be given to it. Fortunately, the twentieth century has already developed two new methods which might replace the older plans. The first of these is the transit micrometer, in which a motion is given to the wire in the field of the telescope so that it shall follow closely the motion of the image of a star as it transits through the field. A wide difference of opinion exists among leading astronomers as to the best method of securing this motion. In the earlier instruments constructed by Repsold, the motion was given by a screw turned by the two hands alternately. This method certainly gives excellent results and is still used largely in geodetic work. Any one who has tried it will find that with the rapid motion of an equatorial star under a high power it is difficult to satisfy himself that the wire always bisects the star. If clockwork is used, the rate must vary with the declination and it is strange that this is not done by electrical control, instead of the somewhat crude mechanical devices now employed. The wire records its position automatically on a chronograph at short intervals. The plan of permitting this record only when the observer is satisfied that coincidence takes place, as is done at Heidelberg, seems a good one. Evidently a certain relative motion will give better results than a greater or less motion. It would appear to follow logically that this apparent motion should be given to all stars and the record permitted only for the few seconds of apparent coincidence. We can

expect no better results than those obtained with a filar micrometer. The best plan may therefore prove to be to give a motion to the wire nearly equal to that of the star, whatever the declination of the latter, by a suitable variation of the clockwork. The best rate could readily be determined by observing stars at different distances from the Pole. Successive settings should then be made as with a filar micrometer, closing the circuit on the chronograph only when the bisection was satisfactory. A similar setting should also be made for the declinations. The two coordinates could thus be determined with an accuracy substantially the same as that of a filar micrometer. Experience has shown that one star a minute can be observed in both coordinates with the transit micrometer. There can be little doubt that positions could thus be obtained with much greater accuracy than by the methods now in use. The special advantage would be the elimination of systematic errors.

A second method of determining positions, recently developed at the Allegheny Observatory, is by plates taken with a photographic doublet. Ordinary plates must be replaced by those of plate glass. By taking suitable precautions positions may be determined of even the faintest stars, with an accuracy at least equal to that of a meridian circle. To obtain the best results, the field should be about five degrees square on an 8×10 plate. The focal length of the telescope would accordingly be about two meters. The large field would permit the constants of each plate to be derived from stars as bright as the eighth magnitude. The economy of this method would be very great, as compared with a meridian circle. The usefulness of the latter instrument appears to be confined to observations of the brighter stars. Accordingly, its aperture may be reduced. The ideal plan would apparently be to divide the sky into regions five degrees square and select in each, five or more stars of about the eighth magnitude and of approximately the same class of spectrum as Class K, so that all should have about the same color. The positions of these should be determined with the greatest possible accuracy with meridian circles, as described above. Some brighter stars should be included to render available the vast number of observations of these objects made in the past. Positions of the stars in the Gesellschaft Catalogues and all fainter stars should be determined by photography.

Various attempts are now being made to determine the absolute positions of the stars by means of photography. It appears probable that a pier placed under ground will remain free from irregular motions, and that if this can be accomplished, the absolute positions of the stars near the equator can be found by photography. To determine the equinox, Venus and Mercury should be photographed as well as the sun. By the very satisfactory cooperation of the Princeton, Yale and Harvard observatories the position of the moon is now determined by photography. The results of a preliminary discussion indicate an accuracy at least equal to that of the best meridian determinations, those of the Greenwich Observatory.

Excellent progress is also being made in determining the parallax of the stars by photography. The recent increase in accuracy is at least ten fold, or that of another place of decimals. A hundredth of a second of arc can now be determined with greater accuracy than a tenth of a second, twenty or thirty years ago.

The just criticism has been made of American astronomers that while they have contributed more than their share of

the work in astrophysics the older science of astronomy of position has been greatly neglected. This is partly due to the fact that much of this work has been left to the United States Naval Observatory, which in the past has failed to justify the liberal appropriations made for its support. While Congress has given it for many years a much larger income than that of any other observatory in the world, the law has been such that it is impossible to attain the best results. The superintendent must be a naval officer, instead of an astronomer, and even then must go to sea after a short term. Accordingly, the Naval Observatory during a period of 37 years had 20 superintendents with an average term of less than two years. The Greenwich Observatory during a period of 235 years from 1675 to 1910 has had 8 astronomers royal with an average term of 29 years. The work of the latter institution with but half the income has greatly exceeded that of the Naval Observatory. It should be stated, however, that within the last few weeks, the Naval Observatory has established an admirable wireless time service by which any one can obtain, at trifling expense, accurate time within a tenth of a second. The Navy has no need of a great observatory, from which it derives but little credit. Three successive boards of visitors have pointed out the present unfortunate conditions, but the necessary action has not been taken by Congress. The obvious remedy is to remove the observatory to another department, or place it under the direction of the Smithsonian Institution, and appoint an astronomer at its head. What grander field of work could be undertaken by this observatory than that desired by astronomers and neglected elsewhere. For instance, computers of double star orbits are continually complaining that while a surplus of measures of the easy objects are available, many difficult objects are neglected, although measures of them are greatly needed. The same is true of the asteroids, of variable stars, and in fact in almost every department of astronomy. By making the observations desired by experts, every hour would be saved, and work of the greatest value accumulated.

Astrophysics assumed prominence as a science about forty years ago, although it was foreshadowed by certain far-seeing astronomers like the Herschels, G. P. Bond, Huggins, Draper and others. One department, the study of the light of the stars, was developed much earlier, originating in the Almagest and its revision a thousand years later by Sûfi. These catalogues show that the relative brightness of the stars has not changed sensibly during the last two thousand years. Also, that the human eye has the same sensitiveness to different colors, now as then. Stellar brightness was made a precise science by that great astronomer, William Herschel. His six catalogues, two of which remained unknown for eighty years, give precise measures of the light of the three thousand stars contained in them with an accuracy comparable with recent work.

In 1877, stellar photometry was taken up on a large scale at Harvard. Since then, more than two million photometric settings have been made. A station in Arequipa, Peru, permitted the southern stars to be observed on the same system as the northern stars. We have now, accordingly, measures of about eighty thousand stars, including all of the seventh magnitude and brighter, many of the ninth magnitude, and some as faint as the thirteenth magnitude. The excellent work of the Potsdam Observatory gives measures of the light of fourteen thousand stars including all northern stars of the magnitude 7.5, and

brighter. The Potsdam and Harvard systems agree admirably if a correction is applied for the color or spectrum of the stars. They should never be combined, or compared, unless this correction is applied.

Stellar photography, originating in the work of George Bond in 1857, has revolutionized many departments of astronomy. The great work of a chart of the entire sky, undertaken by the Paris Observatory in cooperation with several others, is a sad example of the danger of undertaking a work on too large a scale. Although several observatories have been continually at work upon it for a quarter of a century, it has been predicted that at least fifty years must elapse before it is completed, and no positions of any southern stars have yet been published. In striking contrast to this is the early completion of the Cape Photographic Durchmusterung which gives the positions and magnitudes of nearly half a million stars south of $-19°$. It illustrates the results of the happy combination of skilful planning with routine organization, conducted on a very large scale. The extension of this work to the North Pole is now being planned, but with the additional condition that the color index as well as the photographic magnitude will be determined. The former will be found by photographing the stars by means of their yellow or red, as well as with their blue, light, the difference in the magnitudes giving the color index. Much might be said of the numerous applications of photography to the determination of stellar magnitude. The sixty-inch reflector of the Mount Wilson Observatory, using exposures of several hours, has succeeded in photographing stars as faint as the twentieth magnitude. An international committee, with members from England, France, Germany, Russia, Holland and the United States, has adopted a scale of magnitudes based on two investigations made at Harvard. One of these was made with the meridian photometer, and the other is an elaborate investigation by Miss H. S. Leavitt of the photographic magnitude of seventy-six stars near the North Pole. A standard scale is thus provided from the first to the twentieth magnitude. We may say from the minus twenty-sixth to the twentieth magnitudes since accordant results for the light of the sun have been obtained by Professors W. H. Pickering and E. S. King. For many purposes, photography may well replace visual photometric measures, since for stars brighter than the fifteenth magnitude photographs may be taken with yellow light. One of the principal uses of measures of the light of the stars is the study of the variables, or those in which the brightness is not constant. A bibliography of these by Miss Cannon is recorded on about forty thousand cards. The number of known variables is now about forty-five hundred, of which three quarters have been discovered by photography, at the Harvard Observatory. There are several kinds of variable stars. Variables of long period undergo changes which repeat themselves somewhat irregularly in a period of several months, and at maximum are often several thousand times as bright as at minimum. The most useful work that an amateur can do with a small telescope is the observation of these objects. An important work undertaken by the British Astronomical Association has been the observation of variable stars. During the last thirteen years they have accumulated twenty thousand such observations, all reduced to the same scale, which is that of the Harvard Photometry. Similar work in this country has accumulated ten and sixteen thousand observa-

tions in the last two years, respectively. Variables of short period complete their changes in a few days, or hours. Professor Bailey has found five hundred such objects in the globular clusters. In one of these clusters, Messier 3, out of a thousand stars one seventh are variable, all have a period of about half a day, and their periods are known within a fraction of a second. Their light changes so rapidly that in one case it doubles in seven minutes. It is a strange thought that out of a thousand stars, looking exactly alike, there should be a hundred little chronometers keeping perfect time, and whose rate is known with such accuracy. About a hundred and fifty variables belong to the Algol class, in which the light is uniform for a large part of the time, undergoing a sudden diminution at regular intervals. This is due to the eclipse of two bodies, one darker than the other, revolving around their common center of gravity. An elaborate theoretical study of this problem has been made at the Princeton Observatory and, largely from the photometric and photographic magnitudes made at Harvard and elsewhere, the dimensions of a large number of these systems have been determined.

Photography still can scarcely compete with other methods where the greatest accuracy is desired, as for instance, the measures with the polarizing photometer by the late Oliver C. Wendell. The masterly use of the selenium photometer by Professor Stebbins gives results for bright stars of still greater accuracy, while the experiments in Germany with the photo-electric cell by Rosenberg and Guthnick give results which promise to revolutionize our present methods. The principal source of error appears to be the varying transparency of the air. The trial of the instrument in a location where the air is exceedingly clear and steady for long periods is greatly to be desired.

During the last twenty-five years photographs have been obtained by the Harvard Observatory in order to furnish a history of the stellar universe. Two similar 8-inch photographic doublets have been used, one mounted at Cambridge for the northern, and the other at Arequipa for the southern stars. With each of these instruments about forty thousand photographs have been taken. The total weight of these plates is about forty tons. As each plate covers a region ten degrees square, every part of the sky has been photographed, on the average, a hundred times. This work is now supplemented by two small Cooke anastigmat lenses, each having a field thirty degrees square. The number of plates taken with these two instruments are nine thousand and fourteen thousand, respectively. The exposures with the larger instruments are, in general, ten minutes, showing stars of the thirteenth magnitude. The exposures with the smaller instruments are one hour, showing stars of the eleventh magnitude. A continuous history of the sky is thus furnished from which the magnitude and position of any stellar object of sufficient brightness can be determined for a large number of nights during the last quarter of a century. A striking illustration of the value of this collection occurred when the planet Eros was discovered in 1898. It appeared that this object was nearer the earth in 1894 than would occur again for thirty-five years. An examination of the photographs showed its presence on 23 plates, and from their positions the parallax of the sun and mass of the earth were determined with an accuracy equal to that of any of the methods previously used, and on which an

enormous amount of time and money had been spent.

For many years the Kiel and Harvard observatories have served as distributing centers of astronomical discoveries and observations in Europe and America, respectively. The last new star which is known to have appeared, Nova Geminorum, No. 2, was discovered by Enebo at Dombass, Norway, on Tuesday, March 13, 1912. The cable message was received at Cambridge Wednesday morning, and the star was observed at several American observatories the next evening, or the night following its discovery. An examination of the Harvard photographs showed that two plates had been taken on the preceding Sunday, March 11, on which no trace of the Nova was visible, and two on Monday, March 12, showing it of nearly its full brightness. Photographs taken Wednesday compared with those obtained a few days later showed the wonderful change in its spectrum, from the solar type with dark lines, to the typical spectrum of a Nova with bright lines.

There is no department of astronomy which is now receiving greater attention than the study of the spectra of the stars. Dr. Henry Draper was the first to photograph the lines in a stellar spectrum, although Sir Williams Huggins had already obtained a mark from the spectrum of Sirius, and later was the first to publish his results in successfully photographing stellar spectra. The untimely death of Dr. Draper, in the midst of his work, led to the establishment at Harvard of the Henry Draper Memorial. For nearly thirty years Mrs. Draper has maintained an active interest in this work. By placing a large prism over the objective of a telescope, the light of all the brighter stars in the field are spread out into spectra, so that instead of photographing the spectrum of one star at a time, as with a slit spectroscope, as many as a thousand have sometimes been taken on a single plate. Such photographs, covering the entire sky, have been taken with the two 8-inch doublets already mentioned. A study of the spectra thus obtained enabled Mrs. Fleming to discover many hundred objects whose spectra are peculiar. Among them may be mentioned 10 of the 19 new stars known to have appeared during the years in which she was engaged in this work, while five of the others were also found at Harvard by other observers. She discovered more than two hundred variable stars, 91 out of the 108 stars of the very peculiar fifth type, and showed that these objects occurred only very near the central line of the Milky Way. During the last two or three years a great demand has arisen for the class of spectrum of large numbers of stars. The Harvard photographs show the class of spectrum of nearly two hundred thousand stars. Miss Cannon has, accordingly, undertaken to prepare a catalogue of these objects, with the result that she has already classified about one hundred and fifteen thousand spectra, covering more than one half of the sky. The work is progressing at the rate of five thousand stars monthly, and the results will fill seven of the large quarto *Annals* of the Harvard Observatory. The organization of this work has required the most careful application of the principles of "scientific management."

One of the most important results derived from the Harvard photographs was the discovery that in certain spectra the lines were alternately double and single. This, and the discovery by Vogel at Potsdam that the lines of the variable star Algol continually changed their position revealed the existence of spectroscopic binaries. No department of astronomy is

receiving more attention, at the present time, than these objects, and in general the motion of the stars in the line of sight. The Lick, Yerkes, Greenwich, Potsdam, Bonn and Ottawa observatories are only a portion of those directing a large part of their energy to this subject.

One of the most important generalizations of recent times is the discovery by Professor Campbell that the velocity of a star depends upon its class of spectrum. The proper motion of a star was similarly found by the late Lewis Boss to be dependent on the same quantity.

In conclusion, the United States has attained an enviable position in the newer departments of astronomy. Can this be maintained? In Europe, especially in Germany, observatories and instruments of the highest grade are now being constructed, the government furnishing appliances with the most liberal hand. Perhaps the most promising sign for the future is the friendly cooperation of American astronomers, which has never been more marked than at the present time.

The possibilities of work are now greater than ever before. A small fraction of the effort expended in teaching science if devoted to its extension and progress would fulfil the objects of the American Association for the Advancement of Science.

EDWARD C. PICKERING

PROGRESS OF THE CHEMISTRY OF AGRICULTURE[1]

IT is the object of this address to present briefly the important recent advances made in agricultural chemistry. In so doing, it is not my intention to go back one hundred years or fifty years or even to the period included in the memory of the veterans of this association; but only to consider such a period as is within the memory and the experience of a youngster like myself.

Agricultural chemistry is so closely interwoven with the other sciences which have been applied to agriculture, that it is practically impossible to disentangle them. Hence, to a certain extent, the progress of the chemistry of agriculture is closely related to the progress of other agricultural sciences, and to agricultural science, in general. The contributions of the chemist to agricultural science have been so many, so varied and so important, that for a long time the sciences applied to agriculture have been termed agricultural chemistry. This period is passing, and the term agricultural chemistry is being more restricted in its significance, but the field is still broad, and the harvest bountiful to the worker who seeks to garner the grain of knowledge.

There has been a tendency in some colleges to discontinue the teaching of agricultural chemistry, and to divide the subject-matter between the agronomist and the animal husbandman. It is a serious question whether such tendency is in accord with the known laws of specialization in science. There is no doubt but that, as time goes on, the agricultural chemist must specialize more and more in one of these fields of work, but there is a difference between the specialization of the scientist in his own field, and the attempt of other branches of agricultural science to take over the work of the chemist, or the chemist to take over other branches of agricultural science. As I see it, both the agronomist and the animal husbandman have their special problems. They must have their special training in their own fields, and while this training must include some chemistry, it is not sufficient in quantity to

[1] Presidential address before the Association of Official Agricultural Chemists of North America (November 18, 1913).

make them into chemists in addition. On the other hand, the chemist must be, first of all, a chemist. The agricultural chemist must have knowledge of soils and animal nutrition, but he should have predominant chemical training and chemical methods of thought. The agronomist and the animal husbandman undoubtedly need the aid of the chemist in the solution of their problems; but they should not seek, at one and the same time, to be both agronomist and chemist. The result of such an effort is either an agronomical chemist or a chemical agronomist. It often results in the chemist becoming also the agronomist. What agricultural science needs is the highly-trained agronomist, working, where needs be, in cooperation with a highly-trained chemist who has perhaps specialized in soils and fertilizer chemistry, each assisting and aiding the other. The same is true of the animal husbandman. We need the animal husbandman, highly trained in his field and with a full knowledge of its peculiar problems, working in cooperation with the agricultural chemist, highly specialized in the chemistry of animal nutrition. In this way, we shall avoid those errors which we so often see when a man enters into a field outside of his special training—errors which the specialist immediately recognizes. The truth of the matter is, that the chemist has made such great contributions to the field of agricultural science, that the agronomist and the animal husbandman have, in many cases, not been able to see their own peculiar problems, but have emphasized the chemical side of the subject. They have not wholly found themselves. In some institutions, agricultural chemistry is no longer taught. This, we believe, is a mistake. The student needs a thorough grounding in the entire field, such as is given by the agricultural chemist, and he needs to look at agriculture, for a time, from the point of view of the chemist. Specialization should come later.

These matters will adjust themselves in time. We need not fear that the science of agriculture will ever be without the need of the agricultural chemist. Our ranks have not thinned, but each step of progress has rather added to our numbers. The Adams Act, for example, which is one of the most important events in the recent history of agricultural science, has increased the number of agricultural chemists, as well as the number of other agricultural investigators.

The Adams Act, of March 16, 1906, is important, not only from the fact that it increased the number of scientific agricultural workers in the experiment stations, and their facilities for investigation, but because it affords to the experiment stations opportunity for fundamental research work. The passage of the Adams Act indeed marked an epoch in the history of agricultural science. The experiment stations had previously done much valuable work, and accumulated much data, a fact which the passage of the Adams Act itself recognizes. But the experiment stations had such large demands upon them for immediate and practical information, that they had little time for the investigation of fundamental things, no less practical in their final application, but requiring more time, more patience and less obvious in their practical applications. But under the Adams Act, the experiment stations not only may, but must, conduct research. Fundamental and continuous work may be done upon projects which have no present popular appeal, though no one can predict the ultimate effect of such work. The result of the Adams Act has been an increase in personnel and in facilities for the experiment stations, and it has aided in

creating a demand for more highly trained research assistants. It has also tended to raise the standard of scientific publications of the stations. Thus, as I said, with the passage of the Adams Act, the experiment stations entered upon a new period of their existence, one in which fundamental research becomes a much greater portion of their functions than has been the case in the past. It is true that some directors of stations, and some governing boards, do not yet understand the true significance of research, or the qualifications necessary to pursue it. It is true that some station men do not, in their publications, give proper references to previous work, which may have anticipated their own. It is true that in bulletins and in reports of directors, we sometimes find claims of credit for work which are exaggerated, or perhaps the credit belongs elsewhere; claims which are hardly pardonable, even after making all possible allowance for natural exaggerated opinions of one's own work. Such things will pass away. We need more criticism of our agricultural publications—not destructive criticism, but friendly criticism, and friendly controversies over disputed points. Criticism of the proper kind is a stimulant to good work, and aids in pruning away excrescences such as those mentioned above.

The Adams Act created a demand for men capable of research in agricultural chemistry, and other lines of agricultural science. Research is not an ordinary qualification, even in young men just graduated from college. The ability to do research work must be founded upon a natural ability and inclination towards such work, developed by broad general training, and wide knowledge of some particular science, and by an apprenticeship under one who is himself a master of research. This apprenticeship may be during a course of work and study for the degree of Doctor of Philosophy; but it may also be in the process of regular station work under some eminent station investigator. We must recognize the fact that all men capable of research have not been able to secure the Doctor's degree, even though they have done equivalent work. The ability to do research work may be developed by study and training, but it can not be created.

The Adams Act thus marks an important step in the progress of agricultural chemistry, other agricultural sciences and agriculture, as a whole. Perhaps equally as significant was the passage of the National Food and Drugs Act, approved June 30, 1906. Taken in a broad way, the passage of this act was one of a series of events in the reaction of the people against dishonest commercial practises. It has become evident that the people will no longer tolerate practises which have crept into use, which are morally wrong, but were formerly considered as all right because they were business; practises which deceive the buyer or give unfair advantages in business competition. Business has been a species of warfare, but just as it is now contrary to the laws of civilized warfare to kill women and children and burn private dwellings, so it is becoming contrary to the laws of business warfare to cheat women and children and to deceive the purchaser as far as possible. How much the agitation for the pure food and drug law had to do with this moral awakening, no one can say, but no doubt this crusade of twenty-two years had much to do with it—a crusade by an agricultural chemist, Dr. Harvey W. Wiley, for many years chief of the Bureau of Chemistry; secretary of the Association of Official Chemists from its organization until only a little more than a year ago, now our hon-

orary president—for whom all of us have a warm place in our hearts.

The Food and Drugs Act has resulted in a material clearing of the atmosphere, with respect to the naming, labeling and adulteration of foods, drugs and feeds. We now have very clearly defined the objects of such a law. These are, first, to prevent the sale of any unwholesome or deleterious substance, and second, to ensure that the goods delivered to the purchaser shall be exactly as represented. These principles have been made clear, not only with respect to foods and drugs, but also with respect to feeds, and feed manufacturers are beginning to realize that a mixture of bran and screenings may no longer be sold as bran, or a mixture of corn bran and corn chops, sold as corn chops. There are some feed manufacturers who have not yet read aright the signs of the times, as, for example, some of the manufacturers of cottonseed meal, who contend for the authority to sell a mixture of meal and hulls under the name of cottonseed meal, but undoubtedly the time will come when this matter will be made clear.

This association has played an important part with respect to food adulteration. Before 1900, there was one referee and one associate on this subject. At the 1900 meeting, provision was made for 14 associate referees, and there are now 21 associate referees. In addition, we have our committee on food standards, which has done valuable work.

In the matter of cattle feeds, their analysis and adulteration, it appears this association has done little in recent years. The analysis and control of these feeds are yearly assuming a greater importance. There should be a referee and an associate referee on the adulteration of feeds and methods for their detection. We have no official methods on this phase of the subject, beyond the ordinary analysis. The method for crude fiber should be thoroughly studied, and perhaps modified. The clause which permits filtration through cloth should be eliminated. The estimation of crude fiber is becoming more and more important, for by its use we can detect more easily the addition of materials rich in crude fiber, to concentrated feeds. The estimation of crude fiber, for example, shows much more clearly the probable quantity of cottonseed hulls in cottonseed meal, or rice hulls in rice bran, than does any estimation of protein and fat.

Striking progress has been made in recent years in the study of soils. This applies especially to the survey and mapping of soils. In this work, the Bureau of Soils is easily the leader. There is a tendency in some quarters to regard the survey, mapping and analysis of soils as an end in itself. It is true that such work is highly important, but it should also be regarded as a basis on which to make further soil investigations so that we may become fully familiar with the properties and characteristics of each type. In a sense, the soil survey should be regarded as the beginning of soil studies.

In other respects our knowledge of soils has been increased by recent investigations. We now know more concerning the nature and constituents of the organic matter of the soil, and something more concerning its biological properties. We also know that, on an average, the needs of the soil for fertilizer nitrogen in pot experiments is related to the total nitrogen of the soil. We know that the active potash of the soil is related to the average needs of the soil for potash in pot experiments, and that plants have the power to exhaust the active potash and to take up more potash than they need. We know that, on an average, the active phosphoric acid of the soil is re-

lated to the needs of the soil for phosphoric acid in pot experiments. The relation of the pot experiments, and the analysis, to field needs, must be worked out. Soils also deviate from the average, as regards their plant food content and behavior to pot experiments; such deviations must be studied and their causes ascertained. There is much to be done, but progress is being made.

In the field of animal chemistry, decided progress has been made in recent years. We must now recognize the possibility, that, in digestion, proteids of different kinds may be split into different products, some of which may be unfit for use as structural material in building up animal proteids, and so must be discarded. We know that this is possible, but we have not yet secured positive evidence that such occurs with any of the various proteids fed domestic animals. Such studies may be expected in the future.

It has been shown, without doubt, that the digested materials of different feeds have different values to the animals. One pound of digestible nitrogen-free extract in corn has a much greater value than one pound of digestible nitrogen-free extract in straw. The fact that there is a difference in the values of digested nutrients of the same class but from different feeds has been clearly shown by the work of Kellner and of Armsby. There is no doubt about it. It is a step forward to recognize the differences in the values of the digested nutrients and to adjust our tables, our rations and our calculations accordingly. There is abundant room for work along this line, but enough work has already been done to justify this advance. Nearly every American book which deals with the feeding of animals still assumes that the digestible nutrients of one feed are equal in nutritive value, pound for pound, to the digestible nutrients of the same class in any other feed. These books must be re-written and adjusted to our latest advances in knowledge. This advance will, to a certain extent, reconcile the differences between the effects of feeds or of rations in feeding experiments which, under the old standards, should have apparently the same nutritive values.

We are now able to state the nutritive value of a feed in terms of three factors: its bulk, which satisfies the hunger of the animal; its proteids, which repair flesh or tissue, or which, in excess, may be used for fat or energy; its fat-producing value, which is its ability to furnish the animal with heat or energy or to form fat. The fat-producing value of a feed or nutrient is determined experimentally. First, the fattening animal is fed a ration which produces a slight gain of fat, and the gain of fat is measured by determining the income and outgo of carbon and nitrogen. Next, the nutrient or feed is added to this ration, and the gain in fat again determined. The difference in the quantity of fat produced is due to the added feed or nutrient.

The results of such work can be readily compared with calculations based on the assumed equality of the same group of nutrients in different feeds. While the calculated value of peanut meal or linseed meal is practically equal to that found, the value for a wheat straw is only 20 per cent. of that calculated, of meadow hay 54 per cent., of rye bran 79 per cent. of that calculated.

It should be clear that the recent advances in the chemistry of animal nutrition compel us to modify materially tables of feeding values, rations, and methods of calculation. There is opportunity for useful and valuable work along the lines of determining exactly the productive values

of feeds and nutrients, and such work may be expected in the future.

In the thirteen years of the twentieth century the progress of agricultural chemistry has been such as to satisfy even the pessimist that we are moving forward. Our facilities for scientific investigation have been increased by the Adams Act. Our supervision over foods, drugs and feeds has been enlarged and rendered more effective through the Federal Food and Drugs Act. We have made great progress in the survey and mapping of soils and in our knowledge of their properties and chemical composition. The science of animal nutrition has made such advances as to render it necessary to revise almost all books dealing with the subject, and to modify our methods of stating the nutritive values of feeds, and our methods of calculating rations for feeding animals. These have been the four chief lines of advance of agricultural chemistry in recent years. The members of the Association of Official Agricultural Chemists may well take pride in the part they have taken in the progress that has been made.

G. S. Fraps

THE NEW YORK STATE VETERINARY COLLEGE AT CORNELL UNIVERSITY

This occasion[1] is to commemorate the opening of a suitable hospital for large and small animals and halls for the teaching of veterinary medicine. It has greater significance than the mere addition of new buildings to our working equipment, for it introduces into the teaching of clinical medicine methods of precision which heretofore could not be employed. We believe it is desirable that the public should know what the university and the state are doing to increase the efficiency of the veterinary profession.

In the development of veterinary medicine in America, Cornell University holds a conspicuous place. It was the first institution of higher learning to place veterinary medicine on par with other sciences. When its doors opened in 1868, there was among its professors a veterinarian. A department of veterinary medicine was established and it continued as such until 1896. During those twenty-eight years, the head of that department, our distinguished and beloved Dr. Law, was not only an adviser in university affairs, but also a leader in the important work of the nation in eradicating those diseases of cattle that cost Great Britain and her colonies hundreds of millions of dollars. Had it not been for the broad views of Ezra Cornell and President White relative to the teaching of applied sciences in Cornell University, where Daniel E. Salmon, Theobald Smith and Leonard Pearson were trained, the losses on British soil from contagious pleuropneumonia, piroplasmoses and foot and mouth disease might easily have been duplicated in this country.

At the time the department of veterinary science was organized in the university, it was not thought in this country to be necessary to expend large sums of money for veterinary education. The American people experienced with the resignation of the fatalist a steadily increasing loss from diseases of animals. Because of the enormous live stock industry and export trade in cattle and animal products, this loss was not generally felt. The time was approaching, however, when our meat and dairy products would be required to feed our own people and when the losses sustained from disease would be added to the cost of living. This condition was as inevitable here as it had been in Great Brit-

[1] Opening of hospital and clinic buildings, New York State Veterinary College at Cornell University, November 15, 1913.

ain and Germany. It was with prophetic insight that the founders of this institution planned to meet the needs of the approaching situation. It was clear to them that when the law of supply and demand raised the price of meat to a certain height it would be necessary to save the thousands of animals that were annually falling victims of preventable disease. In recognition of this, veterinary teaching at the university began in a small way, but from the beginning its growth was assured.

A second advance was made when the university and the state formed a partnership in which the university was to give toward a veterinary curriculum such instruction as it possessed and the state was to furnish the other necessary teachers, buildings and equipment to complete a veterinary college. By this act, the veterinary department was transformed into a college and a greater work was undertaken. The statute establishing the New York State Veterinary College at Cornell University states that its function shall be the pursuit of such researches and the preparation of such diagnostic and prophylactic agents as may be necessary to protect our domesticated animals against disease and to give instruction in veterinary medicine and surgery. The framers of that law saw with great clearness that the live stock interests of the state required for the control of disease men with a thorough training in the sciences upon which the art of medicine rests. They recognized that the high purpose of the veterinary profession was to prevent quite as much as to treat diseases of animals. This required that students of veterinary medicine should have a preliminary education sufficient to intelligently study those sciences which have revealed the nature of disease. To provide for this, the law requires that in order to enter a veterinary college in this state, the student shall have satisfactorily completed a four-year high school course or its equivalent. This was a long step in advance educationally, although many considered such a preparation unnecessary. There seemed to be a feeling that the successful practise of veterinary medicine in this country did not require the knowledge or discipline that experience had demonstrated as necessary for its success in Europe. However, the great champion of higher veterinary education in this country firmly insisted on the higher entrance requirements. For his perseverance in this cause alone, future generations will look upon Dr. Law as the foremost veterinary educator in America.

This college opened in 1896 with the main building, one story of the north wing and a small clinic building and hospital. These cost the state $150,000. For reasons mentioned, the number of students was small, a total of eleven, and the faculty consisted of eight teachers. For several years, there were no additional buildings and the students increased in number very slowly. The principle of higher veterinary education was on trial. Finally growth was in evidence. The Flower library was endowed with $10,000. An operating room was built on the surgical hospital and the second story of the north wing was added. These cost $27,050. In 1908, the trustees of the university set aside for the veterinary college a farm of one hundred acres for use in the study of animal diseases. And finally, there has just been completed, but not equipped, the hospital for large and small animals and clinic halls for teaching veterinary medicine. These have cost $140,000. The state has a total of $317,050 invested in buildings and $54,000 in equipment. The college, however, is not yet completed. There remain to be added the south wing to the main building and a

diagnosis and pathological laboratory. It is estimated that they will cost $200,000. While these appropriations may seem large, it is well to know that the little country of Norway, with far less live stock than the Empire State, has recently built a national veterinary college at a cost of 2,300,000 krona ($644,000) or a hundred thousand dollars more than the plans of this college call for.

The completion of suitable hospitals for large and small animals, clinic halls and diagnostic laboratories adapted to the teaching of clinical medicine justifies our calling this the beginning of the third era in the development of veterinary medicine at Cornell University. The opening of these splendid wards is significant not only from the pedagogic point of view but also from the standpoint of better veterinary service in the state. The thought of the leading educators in human medicine has been that the teachers of medicine should have adequate hospital facilities to study disease in all of its phases and that they should not be distracted by private practise. This ideal toward which our best medical colleges have been striving has been attained in but few institutions. In this particular, we are fortunate. With ample hospital and clinical facilities and men eminently fitted for teaching veterinary medicine, it is confidently expected that greater efficiency will not only characterize the teaching of students but also increase the application of better methods for the treatment, prevention and control of animal diseases in the state. In rejoicing that such opportunities have been provided, we must not be boastful, for in the acquisition of such facilities, the states of Iowa, Ohio and Pennsylvania have led the Empire State. We do rejoice, however, that America is beginning to realize that if the fearful losses from animal diseases are to be checked here as they are in Europe, veterinary medicine must be taught and practised along equally scientific lines.

The work of the veterinarian is not generally understood or appreciated. It is not the only purpose of a veterinary college to teach men how to treat the accidental ills of animals. In addition to this, the veterinarian has to advise the owners how to protect their flocks and herds from the diseases which are liable to attack them. In New York state there are $290,000,000 invested in animals. The annual revenue from this investment is $140,000,000 or nearly two fifths of the total agricultural product of the state. It has been conservatively estimated that the loss from disease is ten per cent. One of the problems for the veterinarian is to save to the live stock industry all that is preventable of the $29,000,000 loss on investment and to restore as much as possible of the loss in production due to disease. The control of the diseases of animals communicable to man is not a task of small proportions. The inspection of dairy cattle to detect and eliminate those whose milk is dangerous, to inspect the meat from diseased animals that are killed for food, and the many other services of a sanitary, humane or economic significance require a large fund of technical knowledge. It is not my desire to dwell upon the multitude of needed services the trained veterinarian can render but rather to call attention to the efforts that are being made to qualify men for such work.

I have already mentioned the purpose of the founders of this college and the somewhat discouraging outlook at its opening. Starting with an initial enrollment of eleven students in all classes and a faculty of eight, we have now a registration of one hundred and twenty-three undergraduate students and five graduates and a faculty of nine-

teen men who devote their entire time to teaching and research. Knowing that the state would not require a large number of veterinary graduates in any one year, the college was planned, as you can see from your inspection, to teach from fifty to seventy-five students in each class. This is all the veterinarians that the live stock interests of the state will require for many years.

The general tendency toward increased efficiency has been exemplified in this college by the adoption of certain procedures to extend its usefulness. An optional four-year course has been offered and several students are taking it. This was done to make it possible for those who desire to devote more time to their preparation for professional work. We hope in the near future to make the four-year course compulsory. There is a difference of opinion on this point. It is thought by some that it would be better to have one year of university work required for entrance than to have a four-year professional course with the present lower entrance requirements.

A combined course with the college of agriculture has been arranged so that students may receive both degrees in six years. A few students are already taking this course.

The ambulatory clinic was established to enable senior students to visit with an instructor sick animals in the near vicinity of the college. This gives a touch of actual practise in connection with class-room and laboratory work.

In 1908 there was established an annual conference for veterinarians. The faculty appreciated its opportunity to assist the practitioners of the state by introducing a short course of instruction on the most important veterinary subjects of the day. Every licensed veterinarian of the state is invited. Last year fully 15 per cent. of the active practitioners of the state attended this conference.

In June of this year a conrse in practical horseshoeing for the horseshoers of the state was authorized. This is under the immediate supervision of an experienced horseshoer who was trained in the leading schools of Europe.

The research work that is being done at the veterinary experiment station as well as in the laboratories is not only of great value to the live stock owners of the state and of much teaching significance, but it also brings the students in contact with the actual problems with which the practitioner has to deal in the active warfare against disease. It is by these and other methods that the New York State Veterinary College at Cornell University is striving to be a positive factor in alleviating the suffering among domesticated animals and in saving to the owners the losses from disease.

VERANUS A. MOORE

STEREOSCOPIC EFFECTS IN PHOTOGRAPHY

THE exhibition of scientific photography which was recently held at Vienna in connection with the Austro-German Medical Congress contains, according to an article in the London *Times*, an exhibit which marks a great advance in the progress of photography. This is a series of photographs in which true plastic effect is obtained without the employment of a stereoscope or any other optical instrument. For the various objects depicted to stand out in their true relations to one another all that is required is that the picture should be looked at directly and not from one side or the other.

The method by which this result is obtained is, briefly, as follows: A double negative is made in the ordinary way by the use of a stereoscopic camera with twin lenses. Instead of the reconstruction by means of the stereoscope of the plastic image from the

pictures thus obtained the inventors, Herr Friedmann and Herr Reiffenstein, have devised another means of making each eye see only one, and that one its own particular image. This consists of the application of the fact that when placed against a white background the image on a positive transparency is visible and that when seen against a black background it becomes invisible, while should the image be bleached the contrary is the case. From the negatives which have been obtained in the ordinary way with the stereoscopic camera are made, therefore, from one, an ordinary transparent positive, and, from the other, a negative which is afterwards bleached. Let it be assumed that from the negative corresponding to the image seen with the right eye the ordinary positive is made and that the left eye's picture becomes the bleached negative. If these two transparencies were super-imposed one upon the other and laid upon a white background only the right-eye picture would be visible. On the other hand, if placed upon a black background only the left-eye picture would be seen. It is, however, necessary that both eyes should see their respective pictures simultaneously. For this a background is required which to the right eye appears white and to the left eye black. This is provided by a sheet of glass, the back surface of which is prepared in a special manner, while the front surface is ribbed convexly, whereby the rays of light falling upon this surface are broken in such a way as to make it appear black or white according as looked at from one side or the other. The problem is, therefore, solved. The two transparencies are placed one upon the other and then both upon this background. The right eye sees only its proper image and the left eye likewise. These combine automatically, as is the case when a stereoscope is used, and the result is a true plastic picture.

The inventors exhibit five or six specimens of such photographs to which they have given the name of "stereographs." Three of these appeared to the writer of this article to be almost faultless. One of them represented a lump of quartz in which even the shimmer on the surface was reproduced; another, a spray of orchids in a vase, and the third, the skeleton of a gorilla. In the other specimens the two images did not seem to combine easily. The inventors are making arrangements for the manufacture in cheap and handy form of "backgrounds" which they hope before long to have brought to such a state of perfection that the process will be generally employed. With such "backgrounds" the inventors state that pictures can be looked at like any other photograph. In the case of the stereographs now being exhibited the effect of the black-and-white background is, however, obtained by a different method, which necessitates their being viewed by transmitted light.

SCIENTIFIC NOTES AND NEWS

The sixty-fifth meeting of the American Association for the Advancement of Science opened at Atlanta on Monday, Dr. Edmund B. Wilson, of Columbia University, being introduced as president, and Professor Edward C. Pickering, of Harvard University, giving the address of the retiring president on "The Study of the Stars," printed in this issue of Science. Subsequent issues will contain other addresses and reports of the meetings at Atlanta and of the meetings held simultaneously at Philadelphia, Princeton, New York and New Haven.

M. Jean Perrin, professor of physical chemistry of the University of Paris, has been given the degree of doctor of science by Columbia University, to which he is this year visiting professor.

Sir Philip Watts, K.C.B., F.R.S., has received the Order of the Rising Sun (second class) from the Emperor of Japan.

Dr. Charles DeGarmo, since 1898 professor of the science and art of education at Cornell University, will retire at the close of the next summer session.

The Senate of the University of St. Andrews has invited Professor J. Arthur Thom-

son, since 1899 regius professor of natural history at Aberdeen, to be the Gifford lecturer for the years 1914 to 1916.

MRS. ELLA FLAGG YOUNG has been reinstated as superintendent of schools by the Chicago Board of Education by a vote of thirteen to seven, the minority of seven declining to cast a ballot.

DR. KEIVIN BURNS, of the Lick Observatory, has been appointed to a post in the Bureau of Standards, Washington.

THE Royal Society's studentship on the foundation of the late Professor Tyndall for scientific research on subjects tending to improve the conditions to which miners are subject has been awarded for the ensuing year to Mr. J. I. Graham, of Bentley Colliery, Doncaster, for an investigation into the cause of spontaneous combustion of coal.

DR. LYMAN C. NEWELL, professor of Chemistry, Boston University, has been elected president of the University Club of Malden, Mass.

AT the educational conference, held at the University of London, beginning on December 26, twenty-one institutions were represented. Mr. James Bryce delivered the inaugural address, entitled "Salient Educational Issues."

"SCENIC Features of North America from the Geological Point of View" is the general subject of a series of illustrated lectures to be given by Professor Wallace W. Atwood, of the department of geology of the University of Chicago, at the West Side center of the University Lecture Association in Chicago. The series begins on January 3 and ends January 31, one lecture being given each week.

THE following public lectures are announced by the Cornell Chapter of the Sigma Xi: "Recent Investigations in Organic Chemistry," by Professor A. W. Browne, January 19; "Electric Operation of Panama Canal Locks," by John W. Upp, M.E., '89, of the General Electric Company, February 3; "Some General Bearings of Embryology," by Professor B. F. Kingsbury, February 23; "Electric Waves and Wireless Telegraphy," by Professor Ernest Merritt, March 30; "The Experimental Development of the Art of Sewage Disposal," by Professor H. N. Ogden, April 30; "Some Recent Problems in Geometry," by Professor Virgil Snyder, May 25.

ON November 20, Professor M. A. Rosanoff, of Clark University, gave a talk before the Sigma Xi Society at the Worcester Polytechnic Institute on his scientific experiences at the *Versammlung deutscher Naturforscher* in Vienna last September.

MR. EMERY C. KOLB, of Grand Canyon, Arizona, gave a lecture, illustrated with colored slides and motion pictures, before the Geographic Society of Chicago on December 19, the title being "Photographic Exploration of the Canyons of the Colorado River."

DR. STUART PATON will give a series of public lectures at Princeton University on Thursday afternoons at five o'clock on The Study of Human Activities in Relation to Social, Educational and Ethical Problems. The dates and subjects are as follows: February 12, "The Individual. Life as a Process of Adjustment"; February 19, "Adjustments in the Reflex, Automatic and Conscious Levels of Activity"; February 26, "Synthetic and Inhibitory Mechanisms"; March 12, "The Personality"; March 19, "The Problem of Degeneracy. The Feeble-minded, the Delinquent, the Criminal"; March 26, "The Intelligent Direction of Human Activities. Education"; April 2, "Science and Culture."

AT the annual public meeting of the Paris Academy of Sciences, held on December 15, M. Gaston Darboux, the permanent secretary, pronounced a eulogy on Henri Poincaré, the famous mathematician, who died in July last year. The speech included an account of Henri Poincaré's early life.

IT is proposed to establish a permanent memorial to the late Sir William White, K.C.B., F.R.S. The Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institute of Marine Engineers, and other bodies are supporting the plan, and

have invited their members to contribute. A general committee under the chairmanship of Lord Brassey has been formed. The form which the memorial is to take will depend upon the support which is given, about $7,500 having already been received.

Dr. Charles Budd Robinson, economic botanist of the Bureau of Science of the Philippine Islands has been killed by natives in the Amboyna Islands in the Malay Archipelago. Dr. Robinson was born in Pictou, N. S., in 1871; he received his bachelor's degree from Dalhousie University in 1891 and his doctor's degree from Columbia University in 1906. He was the author of researches on the economic and systematic botany of the Philippines.

The death is announced in London on December 15, of Dr. Penry Vaughan Bevan, professor of physical science at the Royal Holloway College.

The U. S. Civil Service Commission announces an examination for technical assistant in pharmacology, for men only, to fill vacancies in this position in the Division of Pharmacology, Hygienic Laboratory, Public Health Service, at salaries ranging from $1,800 to $2,000 a year.

The next grants from the Elizabeth Thompson Science Fund will be made in February, 1914. Applications should be sent in to the secretary, Dr. Charles S. Minot, Harvard Medical School, Boston, Mass., before February 1, 1914.

The Edward N. Gibbs Memorial Prize Fund, the income of which amounts to about five hundred dollars, was established by the wife and daughter of the late Edward N. Gibbs, and is used in aiding investigators into the cause and treatment of diseases of the kidney. The recipient of the fund is chosen annually. The committee will select the worker for 1914 about the first of February, and request all persons who desire to work under this fund, to send to the committee of the Edward N. Gibbs Memorial Prize Fund, 17 West 43d Street, N. Y. City, their application together with a statement of their fitness to prosecute such investigations, giving the laboratory in which they have studied, and any researches conducted by them, in order that the committee may be guided in the selection of the recipient of the fund for 1914.

The Colony of the Straits Settlements has voted a sum of £350 to Mr. Chamberlain's fund for the extension of the London School of Tropical Medicine.

News has been received from the Stefansson expedition that the scientific men and members of the crews of the *Alaska* and *Mary Sachs* were safe and well in winter quarters at Collinson Point, fifty miles from Flaxman Island, on the Arctic Circle.

The Puget Sound Marine Station located at Friday Harbor, Washington, will be open next summer under the directorship of Professor Theodore C. Frye, the head of the department of botany at the University of Washington. Plans are under consideration to increase facilities and to make most satisfactory the conditions surrounding the investigations in marine biology which are in progress. The laboratory will be open during the entire summer season. Professor Frye is now in the east consulting with those interested in the problems under consideration at Friday Harbor.

The Second Annual Conference of Editors of Agricultural Colleges and Experiment Stations will be held at the State University of Kentucky, June 25 and 26, 1914. Invitations to this conference have been sent to all the agricultural colleges and stations in the United States. Inquiries in regard to the meeting may be forwarded to B. E. Powell, executive secretary of Conferences, Urbana, Illinois.

At a meeting of the Royal Institute of British Architects, Mr. Lionel Earle, permanent secretary of the Office of Works, in the course of discussion on a paper by Mr. W. A. Forsyth on the repair of ancient buildings, mentioned that the treatment of decaying stone due to sulphuric acid in the air had

given his department much anxiety. The matter was of such far-reaching importance that the treasury had granted a sum of money for one, two, or three years to institute a scientific inquiry, and he hoped to obtain the services of Professor Laurie, of the Heriot-Watt College, Edinburgh, to that end. The Foreign Office had also consented to inquire of the governments of France, Germany, Italy, Greece and America whether any treatment had been evolved in these countries to combat this evil.

AN efficiency limitation of quite a different type from that imposed by the inadequate and dangerous quarters occupied by the United States Geological Survey is presented, according to the annual report of the director, recently made to Secretary Lane, in the restrictions placed in one way or another upon the selection of personnel. Under "lump-sum" appropriations there is a fair opportunity to obtain high-grade service in the scientific and technical positions, yet even here the restraining influence of precedent prevents attaching to the higher positions salaries that are more than a fraction of those which the well-trained specialists best fitted for those positions can obtain for similar work in the service of corporations. This condition has resulted in many of the members of the Geological Survey leaving government service at the time when they have become most valuable as public servants. Thus in the four and one half years ending January, 1913, the number of geologists who left the government service for the primary purpose of bettering their financial condition was 41, and these men are known to have received salaries outside of the public service amounting to an average immediate advance of 149 per cent., or practically two and one half times the salaries paid them by the Geological Survey.

THE Euphrates barrage from Hindich north to Bagdad was opened on December 12. It is the portion of the great irrigation works designed by Sir William Willcocks, the designer of the Assouan dam. The system, according to a dispatch from London to the Boston *Transcript*, will cost, when completed, no less than $115,000,000, of which $25,000,000 has already been expended on the present section of the work, known as the Feluja project. Three million acres of what were in early history the finest agricultural lands are to be eventually reclaimed. When the system is completed the Tigris, the Euphrates and the Akkar Kuf Lake will form part of a controlled system of canals, weirs and barrages, whereby the pernicious silt is to be separated, floods are to be prevented, and wheat-bearing land is to be nourished with water. It is estimated that the cultivated area will be doubled, and that the crop of wheat along the Euphrates will be trebled. The scheme would also result in a vast increase in the yield of cotton. It consists of providing a means of escape for the flood waters of the Euphrates along the depressions of the Pison, but it also entails the construction of a great central canal, regulators to control the supply from the Euphrates at the head of the Sakhnlawia, a weir on the Tigris, a canal for irrigation to the north of Bagdad, another canal along the right bank of the Tigris, and the building of a railway along the left bank of this canal for the transport of the harvests. Moreover, the construction work would include a railway to connect Bagdad with the Mediterranean by a short and cheap route. The project was submitted by Sir William to the Turkish government in 1909, after a year's study of the situation, a study which he continued through the two years subsequently up to the time of his resignation in July, 1911, as adviser to the Turkish Ministry of Public Works.

UNIVERSITY AND EDUCATIONAL NEWS

WESTERN RESERVE UNIVERSITY will receive from the McBride family of Cleveland a lecture foundation with an endowment of $50,000.

THE following changes concerning the admission of students to the Johns Hopkins Medical School have been announced. In 1913 the number of students in each class was limited to ninety. In order to receive consideration applications of incoming students must

this year be made by July 1. After that date the various applications will be sifted and an attempt made to choose the most likely ninety applicants. It has also been decided to increase the requirements for admission in chemistry and, in addition to the 150 hours of laboratory work in inorganic chemistry now required, an additional 90 to 100 hours of laboratory work in organic chemistry will be required of all students desiring to enter the school after October, 1914.

Beginning next year the two-year courses in the college of agriculture at the Ohio State University will be lengthened to three years. The Tuesday before October 15 is the date set for opening and the Friday before March 15, that for closing. Farmers' sons may, with this change made, come to school after harvest and complete the year's work before the spring work begins on the farm. No attempt to extend the subject matter is intended, and the length of the course is practically the same, but boys from the country may engage in practical farming while taking the agricultural course under the new system.

Plans are being perfected for the centennial of the first conferring of degrees by the Yale medical school. Special exercises will be held in Woolsey Hall on Monday afternoon of commencement week from 4 to 6, and historical addresses, the conferring of honorary degrees, exhibits and other features will be arranged.

Mr. A. W. McCoy (A.B., A.M., Missouri) instructor in geology at the University of Missouri, has been elected instructor in geology at the University of Oklahoma.

The General Board of Studies of Cambridge University have appointed Dr. Assheton to be university lecturer in Animal Embryology.

DISCUSSION AND CORRESPONDENCE

REPLY TO A RECENT CRITIQUE OF AN OLD REVIEW IN SCIENCE

In the current number of the *Bulletin of the American Mathematical Society*, December, 1913, pages 147–151, Professor E. B. Skinner makes erroneous statements regarding my review in Science[1] of Professor L. W. Reid's "The Elements of the Theory of Algebraic Numbers," and also regarding the history of the subject.

1. In my review I had said:

> After stating formally theorem A and devoting fifteen lines to its proof, the author informs us that the "theorem therefore fails." Similarly, on pages 250–251, theorems are formally stated and later shown not to hold in general. This peculiar style of pedagogy is decidedly a novelty to the reviewer.

Quoting only the first sentence and that incorrectly, Professor Skinner insists that the quotation puts the author in a wholly erroneous light. But the entire passage certainly makes clear that I was merely questioning the wisdom of this peculiar style of pedagogy. There was no need whatsoever for any comment in Science on the bare fact that the author stated a formal theorem in italics, devoted a half page to a "proof," and then indicated that the proof failed and that the "theorem" itself was false, repeating the same process on pages 250–251. I think I was justified in presupposing upon the part of a reader of my review that small degree of acumen which would enable him to conclude unguided that if an author devoted considerable space to a false theorem, the failure of the theorem was regarded by him as of sufficient interest to warrant attention. It is unfortunate that the author and Professor Skinner speak also of general theorems which they nowhere state explicitly and which if stated would be false, except in the very simplest cases, as they well knew.

2. In my list of important topics omitted from the book, I included erroneously that of class number. It occurs first on page 434, just seventeen pages before the end of the book. One may be pardoned for not looking at the end of a long book for a topic which should play a fundamental rôle in the whole theory.

3. The last paragraph of my review has gone through a remarkable metamorphosis in the hands of Professor Skinner. What I actually said was:

[1] Science, N. S., Vol. XXXIII., pp. 188–89, February 3, 1911.

In the matter of references the author has been particularly unfortunate. In a book barely entering upon the threshold of the theory, a scarcity of references would have been entirely justifiable. But to give hundreds of references to a certain report on the subject (excellent although it be) and to completely ignore the literature and not even mention the names of the discoverers of the theorems is against all scientific traditions.

What Professor Skinner says I said is:

Again, the reviewer, deploring the omission of references, says: But to give [as above].

My second sentence above (not quoted by Professor Skinner) shows that I did not deplore the omission of references. This sentence together with the one actually quoted by him show that what I deplored was misplaced references. As should be well known, Kummer created a highly complex theory of ideal numbers for the case of fields built upon roots of unity; then Dedekind created a simpler theory of ideals in complete generality and developed the subject at great length; then Hurwitz made a simplification which yields a brief and attractive exposition of the theory; also Dirichlet, Kronecker, Hilbert, Minkowski, Hensel and others have contributed to the development of the subject in various directions. A very large proportion of the theorems stated on pages 218–451, the part dealing with quadratic fields other than Gauss's important case, should have been attributed to Dedekind, provided a reference was to be given. But in these 234 pages, I find only four references to Dedekind, once to an alternative proof, once to a symbol, once to a simple lemma, and finally to a wholly subsidiary theorem. There are two references to Minkowski and one to each Woronoj (on cubic number fields), Hurwitz, Sommer, H. J. S. Smith and to Chystal's algebra. The references to the main theorems are to that excellent report by Hilbert, recently translated into French. As against the four wholly minor references to the originator of the general theory, Dedekind, there are 45 references to Hilbert's report (Professor Skinner's count of 38 for the entire book is misleading as he neglected references given in the body of the text). With a single exception, these 5 references are to passages in Hilbert's report in which Hilbert expressly attributed the results to other writers; had the author reached the higher parts of the theory, he would have needed many references to Hilbert's own important contributions. On my own part the impression that there were hundreds of such references was wrong; but that exaggeration is really beside the mark. The references are largely misplaced and that is evidently all I was emphasizing in the passage quoted above. I do not begin preparation for writing a book review by counting references, and I do not care a straw whether or not Professor Skinner's count of 158 as the total number of footnote references is correct; in any event only about 44 of these relate to the part under discussion. In the above extract from my review I expressly limited myself to the subject of the report and hence to algebraic numbers; consequently it is not a fair comment on that extract to speak of the large number and nature of the references in the introductory part on rational numbers. In all probability these references would have been like those discussed above had the report treated also rational numbers.

4. Professor Skinner states that my review was freely interspersed with exclamation points. As a matter of actual fact only two exclamation points appear in my two-column review. One is in

The author desires to bring out a closer relation between rational numbers and quadratic numbers. This he accomplishes by complicating the elements of rational numbers with the unnecessary machinery of quadratic numbers! We find on page 91 Wilson's theorem stated in the form

$$r_1 r_2 \cdots r_k + 1 \equiv 0 \pmod{p}, \; k = \phi(p),$$

where $r_1, \cdots, r_k$ form a complete set of residues modulo p, a prime.

According to the Index, this is the first statement in the text of Wilson's theorem, which has been known since 1770 under the familiar form that $1 \cdot 2 \cdot 3 \cdots (p-1) + 1$ is divisible by the prime p. After the complicated theorem is stated, proved, generalized and illustrated by several examples, the usual form is finally given. The second exclamation point was used in discussing a three-

page proof which could have been given in a few lines.

5. If, in the three years intervening between my review and his attack on it, Professor Skinner had given less time to the counting of footnotes and more time to the comprehension of the passages quoted from my review and to the unquoted context of those passages, he would possibly have saved himself from "careless and inaccurate statements," instead of attributing that term so freely to my review.

6. Professor Skinner makes on page 150 the remarkable statement:

> Furthermore, the author has put in a very clear light the historical sequence of the ideas which led to the development of the theory.

On the contrary, the author made no such pedagogical blunder. He wisely did not attempt to give any idea of Kummer's ideal numbers, the operations on which are so delicate that one must use the utmost circumspection (as remarked by Dedekind in his important historical papers in Darboux's *Bulletin*). Nor did the author present the second stage (Dedekind's viewpoints) in the historical development of the theory. For most obvious reasons the author refrained from presenting "the historical sequence of the ideas," and confined himself to the simplified present-day exposition of the theory, as far as he went.

L. E. Dickson

A REJOINDER TO DR. DAVENPORT

The task of the critic is always a disagreeable one, and it is only the conviction that the fate of eugenics as a science depends on the repudiation of much of the recent work of the Eugenics Record Office which impels me to reply to Dr. Davenport's letter in Science of November 28. I shall confine myself to the three points he raises regarding the paper on heredity in epilepsy although these points are not in the least representative of my criticism of that paper. Indeed, I dealt with not one, but a whole series of publications in which Dr. Davenport is concerned.

(a) Dr. Davenport states that

> First, Dr. Heron seems to assume that whenever a symbol in a pedigree chart is not accompanied on the chart by some special description it stands for a person about whom nothing is known. He calls attention to numerous cases where, notwithstanding, the corresponding individual is described in the text. The assumption is a gross error. The chart shows mainly the interrelationship of individuals, and indicates only certain traits.

Bulletin No. 2 of the Eugenics Record Office[1] is entitled "The Study of Human Heredity" and the opening sentence reads:

> The following methods are in use at the Eugenics Record Office. . . .

The "plan of charting" adopted is described in section 2 and it is there stated that while the letters E, F, I, N, etc., placed in or around the square or circle which stand for male or female, indicate that the individual in question is epileptic, feebleminded, insane or normal, etc., "when no letter accompanies the individual symbol it means that no definite data had been secured at the time the chart was made" (page 4). Further, Plate V. on page 16 is entitled "Key to Heredity Chart" and there examples of the symbols used are given. The first two are the square and circle without any accompanying letters and the description given is "No data." Again, in his tables Dr. Davenport uses a symbol X which he defines as "Unknown" (I pointed out that more than half the individuals entered in the tables were described by Dr. Davenport himself as "unknown"). Now in the great majority of cases the square or circle without any accompanying letter corresponds to an individual marked "unknown" in the tables, but I pointed out several cases where mistakes had been made. To take the first example I gave in my paper, Fig. 10, case 469, the chart shows two sisters one of whom is marked epileptic while the symbol for the other is left blank to indicate that "no definite data had been secured at the time the chart was made" or that there were "no

[1] It was reprinted in Bulletin No. 7 of the Eugenics Record Office, September, 1912.

data." In the description of the pedigree the first sister is stated to be "certainly epileptic," the second merely "shows signs of epilepsy," while in Table I. both are definitely entered as epileptic. Yet these different statements occur in one and the same study of inheritance in epilepsy.

(*b*) Dr. Davenport writes that,

> Second, Dr. Heron catalogues with infinite pains, "errors" in citing the case numbers. Here he has fallen into a trap which the authors unconsciously prepared for him. To avoid the possibility that a person who is not authorized should connect an individual at the institution with his family history it was decided to apply alterations to the case numbers which enable the authors, but not the ordinary reader, to identify the case.

My criticism was summed up as follows:

> Tables A, C and D (of Drs. Davenport and Week's paper) thus contain particulars regarding the relatives of 74 normal parents. In only 30 cases do the entries agree with the tables from which they are supposed to have been extracted, or with the pedigrees given in the paper In 13 cases out of 74 the case numbere do not agree, while 9 cases which ought to have appeared in Tables C and D have been omitted.

The whole of the errors made were definitely cited by me and the following may be given as examples. Case No. 4529 of Table IV. appears as No. 4521 in Table A *of the same paper* and No. 2124 as No. 2129. Comparing Tables VI. and C we find that No. 335 appears as No. 332, 481 as 483, $\left.\begin{matrix}504\\8781\end{matrix}\right\}$b as $\left.\begin{matrix}503\\3781\end{matrix}\right\}$b, 1705 as 1704, etc. Yet Dr. Davenport now states that these changes were deliberately made by him to hide the identity of the individuals dealt with. I am quite unable to understand how any individual can be identified as No. 4529 and yet escape identification as No. 4521. Perhaps Dr. Davenport will also explain how a pedigree came to appear in Bulletin No. 4, Table VII. as No. 2983, only to be changed in Table D of the same paper to No. 2984, to reappear at the Eugenics Congress as No. 2983 in Table VII. and to return to No. 2984 in Table C.

(*c*) Dr. Davenport states that I overlooked the fact that the details of his pedigrees were sometimes entered in 5 columns and sometimes in 9, 10 or 11 columns (not only in 10 as he states). I was well aware of the fact and made no objection to this procedure since in most cases Dr. Davenport has made up the deficiencies of his "5-column" classification by a long series of footnotes. I did object, however—to cite only a single example—when I found in case 2487 that there were four different versions of the mental condition of a single fraternity of 12 children and pointed out that Dr. Davenport gave of those who died early 0 or 2, of the "unknown" 0, 1 or 6, of the insane 0 or 1, of the neurotic 0, 3, 4 or 5, and of the alcoholic 1 or 2, according to the page consulted. It is for Dr. Davenport to justify these differences.

Finally I would ask those who wish to judge between Dr. Davenport and myself to read my memoir in conjunction with those of Dr. Davenport which I have criticized. They will then be able to judge for themselves whether or not my criticisms are justified. They involved far more serious matters than those to which Dr. Davenport now endeavors to reply.

DAVID HERON

THE FRANCIS GALTON EUGENICS LABORATORY, UNIVERSITY OF LONDON

SCIENTIFIC BOOKS

Researches in Physical Optics with Especial Reference to the Radiation of Electrons. Part I. By R. W. WOOD. Columbia University Press (New York, 1913). Pp. 133, plates 10.

This volume, whose subtitle serves to illustrate the manner in which the electron is dominating current thought in physics, is the most recent number of the Ernest Kempton Adams Series. Of the eleven papers which are here collected all are experimental in character: a large number of the results have already been announced in other places, mainly in the last three or four volumes of the *Philosophical Magazine.*

In point of importance, the first two of these essays, dealing with the truly remarkable phe-

nomena found in the resonance spectra of iodine vapor—phenomena discovered by the author—ought probably to rank highest. The fundamental fact in regard to resonance spectra, namely, that a vapor when illuminated by monochromatic light which comes from a single direction will become self-luminous and will reemit light of the same wave-length in all directions, would appear to put this phenomenon into a category entirely different from that of ordinary fluorescence and to make it extremely worthy of investigation.

The first paper deals with the advantages which came from the use of iodine vapor in place of sodium vapor, and with the structure of the absorption spectrum of iodine, which with Wood's forty-foot spectrograph shows no less than seven lines within the space occupied by the green mercury line alone. Here also is described the curious and unexplained effect of mixing helium with the iodine vapor, namely, the transformation of resonance spectra into banded spectra. Another unexplained phenomenon in this connection is the fact that when the exciting beam of light is polarized this polarization is passed on to the lines of the resonance spectra.

The second paper describes the 40-foot spectrograph with its now celebrated "pussy-cat" attachment and also deals with the absorption spectra of iodine and the emission spectrum of mercury. Wood estimates the number of absorption lines in iodine vapor at 50,000, and recommends it as superior to sunlight for testing large gratings. Important extensions of this work on iodine vapor are reported in the current (November) number of the *Philosophical Magazine*.

The third paper deals with the resonance spectrum of another vapor—that of mercury—which is excited only by ultra-violet light of wave-length 2536. Here is related the discovery of "secondary" resonance, a remarkable radiation, which comes, not from the vapor directly illuminated by the exciting ray, but from those portions of the vapor which are illuminated only by primary resonance radiation. A most interesting feature of this paper is the experimental passage from diffuse to regular reflection of resonating vapor, *i. e.*, from volume to surface reflection. Experiments show that the resonance radiation "begins to weaken at a pressure of about 2 cm. (mercury vapor) and is practically gone at 70 cm."

Next follows a not very successful attempt to determine the anomalous dispersion of mercury vapor in the neighborhood of λ 2536, by use of Puccianti's method. Among the most interesting results in these papers must be reckoned those in which Professor Wood has determined, by experiment, the connection between transparency of a layer of metallic globules and the diameter of those spheres. Using a layer of mercury droplets deposited as "dew" on a quartz plate and examining them for transparency by use of infra-red rays of wave-length 112 μ he finds that these metallic particles have no effect in stopping long heat waves until their diameter begins to exceed one tenth of a wave-length. Very striking also is the fact that such a sheet of small metallic particles—packed together in such a way that they almost touch—seems not at all to interfere with the transparency of those portions of the plate not covered by the metal; the plate remains as transparent for waves of 112 μ as for waves of 1 μ.

Paper No. 6, dealing with diffraction gratings having a controlled groove-form, does not quite reach the level of those which precede it. The next contribution contains some excellent photographic examples of the reflective power of nickel films on glass and numerous details concerning the author's method of depositing these films.

Paper No. 8 carries the title of "Selective Absorption of Light on the Moon's Surface and Lunar Petrography," the latter half of which impresses one as rather ambitious. "Petrography" is a word which has too definite a meaning to be employed as a description of local differences of color either on the moon or on any other body. The method employed is that of using different ray-filters for photographing the moon with light from three regions in the spectrum; and then combining the three negatives into a three-color

picture. The silvering process was evidently described during a moment of relaxation when the author's characteristic humor came to the surface as follows: "Personally I never weigh my nitrate of silver, as I enjoy the element of the personal equation which enters the problem when scales are dispensed with." How seriously this is to be taken may be judged from one or two of his immediately following sentences. "From one to two grams to 100 c.c. of distilled water is about right." "Unfortunately things as described above seldom happen at the first trial." "It troubled me much when my personal equation contained one more variable than at present, but I have not seen it occur recently. As the production of the uniform blue film depends upon getting the proportions just right, I suppose the beginner had better mix measured amounts for each trial unless he has access to a large jar of silver nitrate which 'belongs to the department.'" "The cause of this I do not know. Probably it is osmotic or perhaps catalytic!"

The results contained in the next paper, entitled, "Note on the electron atmospheres of metals," are capable of a quite different and less significant interpretation than that given by the author, as has already been pointed out by several other investigators.

The resolution of the four principal mercury lines, by a five-inch plane grating, ruled by Anderson at Baltimore, is discussed in Paper No. 10, and speaks well for the high quality of the grating.

The eleventh paper concludes the series with an interesting explanation and experimental verification of the "Imprisonment of Radiations by Total Reflection."

Of the volume as a whole, one hardly knows whether to admire more the boldness of ideas which prompt the experiments or the manipulative skill with which they are executed.

Henry Crew

Northwestern University

Astronomy: A Popular Handbook. By Harold Jacoby, Rutherford Professor of Astronomy in Columbia University. The Macmillan Company, New York. 1913.

Most astronomers yield at one time or another to the desire to write some popular treatise on astronomy. Professor Jacoby has prepared his volume in the effort "to meet the wishes of the ordinary reader who may desire to inform himself as to the present state of astronomical science, etc." The book is intended also to serve for use in high schools and colleges. To meet this double end, the author has placed all the mathematical notes and explanations in the appendix, where they are at the service of students, while the main body of the text is free from mathematics, which might discourage the "ordinary reader." This method of arrangement is not unusual, but the author has carried it out more systematically than is usually done.

Professor Jacoby's treatment of the subject is distinctly out of the ordinary, and it is this originality of method and style which may well furnish the *raison d' être* for this addition to our astronomical literature. The first chapter is in the form of a general survey of the universe, a prelude to the detailed descriptions which follow. In the third chapter methods are given for finding the planets and stars. This chapter, however interesting for other reasons or valuable for intellectual training, does not impress one as containing the simplest methods for gaining familiarity with the stars and planets. Monthly maps are now published giving the appearance and positions of planets and comets as well as the stars, and it is doubtful if any verbal description, tables and small diagrams can compare in efficiency with such maps in assisting an ordinary reader to the identification of celestial objects. The author, however, would doubtless encourage the use of such maps in connection with the reading of the book. Chapter V. gives a brief but admirable discussion of the sun dial with a description of the manner in which one may be constructed by the reader. The earth and its relationships are handled in an original and interesting way. Under "Moonshine" the author presents the leading facts about our satellite, giving the usual proof of the absence of an atmosphere and the probable cause of its disappearance. No reference is made to the

conclusions of Professor W. H. Pickering, and others, regarding a slight atmosphere and various changes of the lunar surface. The author evidently has little confidence in these observations, since they, if trustworthy, would be of exceptional interest to the "ordinary reader." The different members of the solar system are taken up in order and briefly but clearly described. Probably no other astronomical subject is of such popular interest as the question of the presence of intelligent life on Mars. The author states: "We conclude that neither by visual nor by photographic evidence has the existence of an artificial network of markings been proven, or even rendered highly probable. Therefore the time has not yet come when we shall have to inquire whether geometric lines indicate the presence of intelligent inhabitants: that time will arrive if the lines themselves are ever shown to possess a real or even a highly probable existence." This view is doubtless shared by the great majority of astronomers at the present time.

Throughout the book Professor Jacoby calls attention to the familiar celestial phenomena of life, such as the rising of the sun and moon and their summer and winter paths. In calling attention to such facts and explaining them in a popular manner he has done a real service to the readers of his book. Even among educated people few can answer promptly the question, "Where does the moon rise?", and its changing path during the month and year is either not noticed or regarded as a mystery.

The volume is attractive in form, appears to be free from errors, and is admirably, if not profusely, illustrated. Many lines of recent astronomical advance have been lightly referred to, if at all, but this is inevitable in a popular treatise of such wide scope. The paramount importance of photography in research at the present time might well have been emphasized somewhat more strongly. On the whole, the book is exceptionally well written, and as a popular exposition of the whole field of astronomy is unexcelled.

S. I. Bailey

Elliot's Review of the Primates

For many years the Primates have been in need of systematic revision. The last general work on the order, Forbes's "Handbook," was published in 1894. Study of the group since then, particularly in Berlin, London and Washington, has resulted in a great increase in the number of recognized forms and in the modification of previously accepted views regarding many of those earlier known. In no one of the chief centers of activity is the material extensive enough to form the basis of a general review of the order, and in no two has a common standard of work existed. The resulting confusion was such that the understanding of relationships and the identifying of specimens had become in the larger genera impossible. To remedy these conditions and to establish a foundation for new work are the main objects of Dr. D. G. Elliot's "Review of the Primates."[1] This book is one of the most elaborate monographs ever devoted to a single order of mammals. By its publishing the outlook on the primates has been altered in a way that can be appreciated by those only who have for some time been actively occupied in the study of monkeys. In its 1,351 quarto pages may be found a complete review of the work done in the past by the author himself, his contemporaries and predecessors. It contains descriptions of all the known species drawn up by one person from direct examination of the specimens in all the principal museums of the world. Finally the series of photographs reproduced in 111 of the plates is so well selected and so fine in quality that it might be said almost to exceed in general usefulness the specimens hitherto existing in any one museum.

The inception and plan of the work are thus described by the author (Preface, pp. iii–ix):

[1] "A Review of the Primates," by Daniel Giraud Elliot, D.Sc., F.R.S.E., etc. Monographs of the American Museum of Natural History, Vols. 1–3. Three volumes, quarto, with 169 plates (28 colored). New York, published by the American Museum of Natural History (1912), June, 1913. Price, $30.

"This Review of the Primates is the result of a casual suggestion of my friend Frank M. Chapman, Esq., that I should 'write a book on monkeys.' The magnitude of the task—to compel all the described forms of the Primates to present themselves in their representatives for critical examination and comparison—was thoroughly appreciated, and also it was equally well understood that no institution in the world contained a collection of these animals sufficiently large to permit a work like the present to be completed by its aid alone. . . . Twice were the museums of England and the Continent visited, . . . and during a journey around the world, the museums and gardens of the Far East were also visited and their collections carefully studied. The author has seen and taken a description of nearly all the types of the primates extant in the world today, and there is not a collection of these animals of any importance existing at the present time with which he is not familiar. The results of five years' continuous study are therefore embodied in this work. . . . In the recognition of apparently distinct forms, subspecies in only comparatively few cases have been accepted, because intermediates between what are recorded as species have rarely been found in this order, and neither of two forms, no matter how closely they are evidently related can properly be deemed a subspecies, no intermediates having been observed. Also the author has not seen his way to establish a subspecies between the dweller of an island and one of the mainland, because, no communication being possible, the appearance of intermediates would seem most improbable. . . . In the present work there are altogether fifty-five complete monographs. . . . Each member of the order has been treated after the following method. First a general review is held of the genus accepted, the type fixed and description given; then remarks are made on the appearance and general habits of the species the genus contains, followed by a review of the literature and the geographical distribution, and a key by means of which it is possible that all the species of that particular genus may be recognized. Then each species is taken up in regular sequence, its synonymy given and the type locality and geographical distribution recorded; the present location of the type, if existing, is then told, after which the peculiar characters of the species, if it possesses any, are given, followed by such remarks as may be necessary upon the relationship the species under review may have with some other in the genus; then a full description and measurements of the type if possible, concluding with an account of the habits so far as they may be unquestionably known. . . . The author can not refrain from calling attention to the illustrations produced by the methods and greatly improved instruments invented by the special photographer of the American Museum, Mr. Abram E. Anderson, which for clearness and perfection of detail, have possibly not been heretofore equalled. Mr. Anderson was sent to London expressly to photograph the crania in the British Museum. . . . The colored illustrations have been selected from those published in the *Proceedings* of the Zoological Society of London. . . . Those of the different species from life were taken by Mr. Lewis Medland, F.Z.S., of London, and certain excellent figures taken by Mr. E. L. Sanborn from animals living in the menagerie of the New York Zoological Society. . . . All the species and races known to the author that have been described prior to June 1, 1912, are included in the three volumes. After the date mentioned, the advanced state of the press work did not permit of any additions, except in an appendix to the third volume."

Following the preface is an introduction of 94 pages, a bibliography of 6 pages, a table of contents, lists of illustrations, list of genera and species in volume 1, and an "errata" calling attention to the single mistake which the author thought necessary to correct. The introduction deals with the general subjects of classification, variation and geographic distribution. There is also a list of the generic names that have been proposed for members of the order, and a complete synopsis of the arrangement adopted: 2 suborders, 8 families,[2]

[2] Although the family *Hylobatidæ* is very properly used to distinguish the gibbons from the true

55 genera,[3] and 588 species and subspecies. Except for the general accounts in the introduction there are no definitions of families and higher groups. There are no keys to the genera, while those provided for the species are not dichotomous.[4] The account of each species is arranged under the following heads: synonymy, type locality, geographic distribution, general characters, color, and measurements, to which is usually added a discussion of characters and some account of habits. Cranial and dental peculiarities are either ignored or superficially treated; a lack which is partly compensated for by the abundance and excellence of the illustrations.

The nomenclature of the Review is uncompromisingly founded on the law of priority.[5] The author's cheerful acceptance of the results, however inconvenient they may temporarily appear, should do much to counteract the present tendency to seek relief in exceptions to the uniform application of this rule. Discussing the name *Simia*, recently shown to apply to the Barbary ape instead of to the orang or chimpanzee, Doctor Elliot says:

"This procedure may be regretted by mammalogists generally, for *Simia* has always been connected with some group of the great apes, but the reasons advanced for doing this were faulty, and an error was committed, and no matter how familiar this act may have become to authors and others generally, yet it was still an error, and therefore something necessary to change and correct. No error can ever become truth simply by toleration and should never be continued when discovered for any reason, and particularly not for the totally insufficient one that the change would inconvenience the memories of certain writers."

The same uncompromising attitude is assumed with regard to every question discussed in the Review: "The conclusions given, no matter how they may disagree at times with the opinions expressed by other laborers in the same field, have in every case been reached only after careful and patient investigation." This strongly personal character of the work is manifest on every page. While it gives the text its chief value it, in connection with the peculiar circumstances under which the manuscript was prepared, accounts also for the main defects. These are the lack of proper correlation between notes made at widely different times and places,[6] and the generally

anthropoids, the number of such groups recognized is still too small. This is particularly true of the American monkeys, all of which, in spite of their great diversity of structure, are, as usual, crowded into two families.

[3] The following generic and subgeneric names are here published for the first time: *Rhinostigma* (I., xl.), type *Cercopithecus hamlyni* Pocock; *Allochrocebus* (I., xl.) type *Cercopithecus l'hoesti* Sclater; *Neocebus* (I., xl.), type *Simia cephus* Linnæus; *Insignicebus* (I., xl.), type *Cercopithecus albigularis* Sykes; *Neopithecus* (I., lx.), accidental renaming of *Neocebus; Altililemur* (I., 111), type *Cheirogaleus medius* Geoffroy; *Brachyteleus* (II., 49), substitute for *Brachyteles* Spix; *Neocebus* (II., 224), included species: *Pithecus resimus, P. validus, P. alacer, P. karimoni* and *P. fuscus* (not *Neocebus* Elliot, I., xl.); *Melanocebus* (II., 296), included species: *Lasiopyga leucampyx, L. pluto, L. nigrigenis, L. boutourlini, L. opisthosticta, L. aurora, L. stuhlmanni, L. neumanni, L. doggetti, L. princeps, L. carruthersi, L. nictitans, L. n. laglaizi, L. sticticeps* and *L. martini; Pseudogorilla* (III., 224), type a young male *Gorilla gorilla* supposed to represent the *G. mayema* of Alix and Bouvier.

[4] There are 17 alternatives beginning with the words "General color" in the key to the species of *Pygathrix* (III., 30–32) and 24 beginning with the word "Hands" in that to the species of *Pithecus* (II., 189–190). Such tabulations of characters can not strictly be regarded as keys.

[5] Except as regards the formation of names. Here the International code is abandoned and personal taste is freely indulged, not always with happy results from the point of view of the purist. For instance, the generic name *Ateles*, evidently intended by Geoffroy as a transliteration of the Greek adjective ἀτελής, is changed to *Ateleus* (II., 21) with the following comment: "Ατελησ (sic α priv. and τελοσ (sic), εοσ (sic) a neuter noun, which with the α priv. would be, when Latinized, *Ateleus*."

[6] At least it is difficult otherwise to explain the frequently-recurring discrepancies such as: the statement on one page that an animal is clove brown and on the next that it is jet black (III., 109, 110); "upperparts bistre" and "upperparts

superficial quality of the descriptions and technical discussions. Nowhere does the author give evidence of felicity in the treatment of those characters of fundamental importance derived from skulls and teeth.[7] The vital part of a monograph of the order therefore remains unwritten. To an experienced systematist the results of such tendencies can not fail to bring annoyance and disappointment, while to a beginner, or to a person who has no access to large collections of primates, they must render the book often confusing and misleading. The frequent inaccuracy of statement by which the text is marred[8] will be a further source of difficulty to every one who attempts to use the Review in any serious work.

In these initial numbers of its series of "Monographs" the American Museum of Natural History has established a high standard of excellence in book-making. Good paper, clear type and unsurpassed half-tone plates are its main characteristics. Consistent italicization of generic and specific names would have made the text more easy to use, one series of numbers instead of four would have made the plates less perplexing to cite, while "editing" might have been expected to eliminate an allusion to the opossum as a member of the order Carnivora (I., xxi.), together with such solecisms as "catarrhine and platarrhine" (I., xxi.), and the almost uniform incorrectness in the printing of Greek.

GERRIT S. MILLER

NOTES ON METEOROLOGY AND CLIMATOLOGY

DYNAMIC PRESSURE UNITS

BEGINNING January 1, 1914, the Blue Hill Meteorological Observatory will use dynamic units of pressure instead of millimeters of

black or nearly so" in two paragraphs of a description based on a single specimen (II., 200); "no skull" as part of a color description (III., 70); the application of the same new subgeneric name to two different groups (II., 224, 319); the application of two new names to one group (I., xl., lx., and II., 319); the listing of the name *Pavianus* under Lemuroidea (I., xxviii.), and again under *Anthropoidea* (I., xxxii.).

[7] The striking peculiarities of the skulls and tooth cusps in the lemurs are barely mentioned; the equally interesting molars of the American monkeys receive no more attention (the remarkably primitive structure shown by those of *Alouatta* is not even alluded to); the molars of the three genera, *Pongo*, *Gorilla* and *Pan*, the cusps of which furnish unmistakable generic characters, are described in practically identical terms; the skull of an ordinary immature male gorilla (the age clearly indicated by the open sutures shown in the photographs) is made the type of a new genus "*Pseudogorilla*" (III., 224), supposed to be intermediate between *Gorilla* and *Pan*. Cranial characters are described for none of the 8 subgenera and for only 3 of the 84 species and subspecies of the genus *Lasiopyga*, though in the preliminary discussion of the monkeys of this group the remark is made that: "Cranial characters . . . are of supreme importance in the discrimination of species . . ." and also that they furnish "one of the most important methods of determining species" (II., 290).

[8] The following examples have been found during actual use of the book, and without search for errors as such: *Tarsius philippinensis* for *T. philippensis* (I., 9, 10, 12, 13); *Nycticebus menagensis* Lydekker, *Zool, Rec.*, etc., for *Lemur menagensis* Lydekker, etc. (I., 32); I. Geoffroy, Cat. Primates, p. 51," cited as authority for alteration of *Brachyteles* to *Brachyteleus* (II., 49) though the change is not mentioned by Geoffroy. (It is apparently published for the first time by Elliot); *Cynopithecus niger* Desm., Mamm., etc., for *Cynocephalus niger* Desm., Mamm., etc., (II., 162); *Cercopithecus mona* Hollister for *Lasiopyga mona* Hollister (II., 350); description of color of *Pygathrix melanolopha* beginning: "Long black hairs along the forehead, golden cream yellow" (III., 33); original reference to the name *Presbytes batuanus* given as "*Presbytis batuanus* (1) . . . p. 470" (III., 44) when it was actually published on p. 65 and with the masculine form of the generic name; *Pygathrix femoralis* (III., 45), Horsfield cited as authority, though first description was published by Martin, type locality said to be "Tenasserim, Bankasun, (Thomas)" though Thomas merely recorded a specimen from Bankasun as "precisely similar" to the type; *Pygathrix obscura* (III., 52), Reid cited as authority though he is said to have published no description; *Callithrix goeldi* Thomas . . . p. 100 for *Midas goeldii* . . . p. 189 (III., 261 and I., 224, *not* 324 as cited on III., 261).

mercury for barometer readings (760 mm. = 29.92 in. = 1,013,303 dynes = 1,013.3 millibars). Also temperatures will be expressed in absolute centigrade degrees (273° A. = 32° F.). Until January 1, 1915, the old units will be retained for comparison with the new. Professor Alexander McAdie, director of the observatory will be glad to help any one wishing to adopt this new pressure scale. These changes were first proposed for adoption in the United States by him in 1908.

In the report for the year ending March 31, 1913, the Meteorological Committee of England announces that the centibar or millibar will be used instead of the inch as far as possible for all barometric measurements. Specimens of daily and weekly weather reports are given with pressures expressed in dynamic pressure units instead of inches of mercury, and with temperatures in absolute centigrade degrees.

RADIATION AND CLOUD GROWTH

In the October *Meteorologische Zeitschrift* [2] Dr. C. Braak, of Batavia, Java, ascribes to radiation certain peculiar phases in the development of cumulus clouds. His description of the formation of these clouds on a calm day may be stated as follows. When the rising sun has warmed the earth sufficiently to drive local air masses to the condensation level, at first single, then many small cumuli appear which soon cover the whole sky. Here and there larger heads rise out of the rather flat cloud sheet. Soon after reaching their maximum height they disappear. If the cumulus growth continues to the cirrus level (about 10 kilometers altitude) the top flattens out. The lower column melts away and leaves this growing sheet. When through energetic upward movement the cumulus cloud rises to even greater heights, there is no longer a maximum level where the vertical movement stops; the condensed moisture falls out, and in the upper parts of the cloud the air flows toward all sides, forming gigantic cirrus rays.

Thus there seems to be a division of the atmosphere into two parts as regards cloud building. This has a certain analogy with the division of the atmosphere into troposphere and stratosphere: the former designates the atmosphere to a height where decrease of temperature with altitude ceases, and the latter, the isothermal region of unknown vertical extent above this. According to Messrs. Gold and Humphreys[3] this is a radiation effect of the air. Below the stratosphere radiation exceeds absorption and convection balances the loss of heat; while in the stratosphere absorption exceeds radiation so the temperature rises over that of convective equilibrium. If one considers the disappearance of the lower part of the cumulus cloud to be the result of cooling and the continuance and energy of the upper part as the result of warming, the analogy becomes nearly complete. Observations in cumulus clouds over Batavia within the lower few kilometers show that the clouds are colder than the surrounding air at the same level. Radiation may thus have greater importance in cloud processes than is commonly assigned to it.

EXCESSIVE PRECIPITATION

Some recent heavy rains have brought out the following records of excessive rainfall for short periods.

Period	Amount	Place	Date
24 hours	1,168 mm.[4]	Baguio, P. I.	July 14–15, 1911
24 hours	544 mm.	Alexandria, La.	June 15–16, 1886
18½ hours	528 mm.	Montell, Tex.	June 28–29, 1913
8 hours	406 mm.[4]	Concord, Pa.	August 5, 1843
80 minutes	292 mm.[4]	Campo, Cal.	August 12, 1891
30 minutes	235 mm.[4]	Guinea, Va.	August 24, 1906
20 minutes	205 mm.[4]	Curtea-de-Arges, Roumania	July 7, 1889
14 minutes	100 mm.	Galveston, Tex.	June 4, 1871
5 minutes	38 mm.	Fort McPherson, Neb.	May 27, 1868
30 seconds	4 mm.	Valdivia, Chile	June 11, 1912

[1] See Alexander McAdie, "New Units in Aerology," *Scientific American* Supplement, December 6, 1913, p. 357.

[2] "Über den Einfluss der Strahlung auf die Wolkenbildung."

[3] See Dr. W. J. Humphreys, *Jour. Franklin Inst.*, March, 1913, pp. 216–222.

[4] Probably world's records.

SOME RECENT PUBLICATIONS

DR. NILS EKHOLM in a recent work[5] makes use of isallobaric charts (charts of equal changes of pressure) in addition to the usual isobaric charts. His study of the former indicates that pressure changes are of primary importance, while cyclonic and anticyclonic phenomena are secondary.

A thorough study of the thunderstorm observations in Germany for 1910 has recently appeared.[6] The thunderstorm observations of 1,570 stations are printed in extenso and summarized in a number of tables. The mean velocity for 979 thunderstorms was 38 kilometers per hour; the extreme velocities were 9 and 95 kilometers per hour. Twenty per cent. of the thunderstorms came in May, forty per cent. in June and twenty per cent. in July. There is a special article on the destructive thunderstorm of May 11, 1910.

The British Rainfall Association under the direction of Dr. H. R. Mill deserves credit for its large 52d volume "British Rainfall, 1912." Part 1 contains three special articles on "The Great Rainstorm of August 25–26, 1912"; "The Wettest Summer in England and Wales," and "The Seathwaite-pattern Raingauge." Part 2 is an extensive treatment of the British rainfall data of 1912. Part 3 is a general table of the rainfall observed at 5,272 stations.

The report of the Franco-Swedish sounding-balloon expedition in Lapland 1907, 1908 and 1909 has been published recently. As in middle latitudes, the base of the stratosphere was encountered at a mean elevation of twelve kilometers with temperatures of — 50° to — 60° C. These temperatures are higher than those at the base of the stratosphere in equatorial regions where records of — 80° C. are not uncommon.[7]

[5] "Das Wetter auf der Nordsee während der erste Hälfte von Juni 1911," Copenhague, 1913.

[6] Th. Arendt, "Ergebnisse der Gewitter-Beobachtungen im Jahre 1910," *Veröff. d. Kön. Preuss. Met. Inst.*, No. 266.

[7] See *Scientific American*, December 6, 1913, p. 432.

The pumping action (suction) of the wind particularly in mountain stations offers a serious obstacle to accurate barometer readings. Mr. G. v. Elsner in a monograph, "Über den Einfluss des Windes auf den Barometerstand an Höhenstationen,"[8] discusses this at length. As yet no way has been found to eliminate this wind effect.

NOTES

IN recognition of the fact that the Blue Hill Meteorological Observatory is now part of the Division of Geology of Harvard University, the members of that Division visited the Observatory November 8. Professor Alexander McAdie, the new Director, gave an address on "Modern Methods of Frost-fighting."

The Smithsonian Institution is to reopen the Langley Aerodynamical Laboratory, which was closed a few years ago. The first serious contribution from the scientific side of aeronautics is to be found in the work of Langley. His original purpose was not to construct a flying machine, but to determine the laws governing flight. Two wind tunnels are to be made for tests on models. In addition to these experiments, an aircraft field-laboratory is proposed for measurements of stress, moments of inertia, etc., and for the adjustment and repair of several full-scale land and water aeroplanes.

The part which high humidity plays in producing heat stroke was well illustrated in Vienna on August 20, 1913. With the relative humidity around eighty per cent. and temperatures between 20° and 23° C., several suffered from heat prostration.

The council of the Royal Meteorological Society has awarded the Symons Gold Medal to Mr. W. H. Dines, F.R.S., in recognition of the valuable work he has done in connection with meteorological science. The medal will be presented at the annual meeting of the society on January 21, 1914.

WE learn from *Nature* (London) that in November the British Meteorological Service

[8] *Veröff. d. Kön. Preuss. Met. Inst.*, No. 257.

began to issue comprehensive meteorological charts of the north Atlantic, somewhat similar to those discontinued by the United States Weather Bureau in August.

Dr. Julius Von Hann's first section of the third edition of his "Lehrbuch der Meteorologie" is now for sale by the publisher, C. H. Tauchnitz, of Leipzig, at 3.60 Marks.

CHARLES F. BROOKS

HARVARD UNIVERSITY

SPECIAL ARTICLES

MUTATION IN TOBACCO

ALTHOUGH recent work by Heribert Nilsson[1] and Davis[2] shows that the sudden changes which were observed in *Œnothera Lamarckiana* can be logically and simply explained by assuming a heterozygous parent, one should not conclude that this seriously weakens the general theory of the origin of new types by mutation. Even if the indirect evidence compiled by De Vries were also to be rejected, there remain a considerable number of mutations that have arisen in homozygous material of known ancestry. The truth of this statement is apparent if it is recalled that such a careful investigator as Morgan has witnessed the origin of over 150 such changes in *Drosophila*. Controlled botanical evidence is not as voluminous, though plant geneticists have all observed phenomena that seem best interpreted in this manner. For this reason we hope it is not out of place to describe the origin of a variation that appeared in 1912 in a field of Connecticut shade-grown tobacco, which seems likely to be of very great commercial value.

The variety of tobacco grown under cheesecloth cover in the Connecticut valley is called Cuban. It was first grown in this country in 1904 from seed which was brought from Cuba the previous year by Mr. William Hazelwood, of New York City. The crop of 1904 was very variable, but Hasslebring[3] has shown that this type of variability is due largely to the poor method of saving seed in Cuba. It is the result of a mixture of seed from various types of plants; for crossing seldom occurs naturally.

Individual plants were selected from the 1904 plot which was grown from Cuban seed, and self-fertilized seed produced by covering the seed head with a Manila paper bag. These individual selections were grown in row tests in 1905 and for succeeding years until 1909. The individual rows grown from self-fertilized plants presented a uniform appearance. Of the earlier types all proved of little commercial value except strain 13. One line known as 13–29 proved superior to all others in the value of the cured leaves. A considerable number of self-fertilized seed plants were saved from this line in 1908 and were used for commercial planting in 1910 at the Windsor Tobacco Growers' Corporation in Bloomfield, giving a crop of uniform appearance, in which no variations of importance were noted. A large quantity of seed was saved from this crop, although individual plants were not selfed, as it seemed very improbable that crossing would take place under the cheese-cloth cover, and even if some crossing took place, it was assumed that it would be between homozygous individuals. The Cuban variety was thus selfed for five generations, and in all probability for a sixth generation, and gave every evidence that it was of a homozygous nature.

In 1912 about one hundred acres, or over a million plants, were grown from the seed of the 1910 crop at the Windsor Tobacco Growers' Corporation. The general appearance of the crop this year was very uniform, but when clearing the field in the fall, one of the workmen was very much surprised to discover that one of the plants he had just cut down was very much taller than the others, and bore a large number of unpicked leaves. This plant was brought to the attention of the plantation manager, Mr. J. B. Stewart, who recognized the possibilities of such a plant. After systematic search two more such plants were discovered. These plants were carefully taken up and carried to the Connecticut Experiment Station greenhouse in New Haven. One of

[1] *Zeitschrift für induktive Abstammungs- und Vererbungslehre*, Band 8, Heft 1 u. 2, 1912.

[2] *Amer. Nat.*, Vol. 46, 1912.

[3] *The Botanical Gazette*, Vol. 53, 1912.

the plants survived, and bore 72 leaves, blossoming about January 1. Considerable seed was saved from both the terminal and lateral inflorescence of this plant.

In 1913 about 5,000 plants were grown from this seed. These plants were true to the new type in all external characters, and differed from the normal Cuban in having a somewhat lighter green shade to the leaves, in an absence of basal suckers (lateral branches), and in a practically indeterminate growth, whereas the normal Cuban variety produces a terminal inflorescence after producing from 16 to 25 leaves on the main stem. Twenty plants were brought to our greenhouse in New Haven; all but eight, however, were injured during transportation. The eight uninjured plants commenced to blossom about the first of November, the range of leaf counts per plant being from 62 to 80, with the greater number around 70. These data show that this tobacco mutant is breeding true, and unless it behaves in a different manner from other mutants, it should breed true in succeeding generations.

The cured leaves are very promising, resembling the normal variety. There is every reason to believe that this new type will prove of commercial value, as the yield per acre is at least fifty per cent. greater than the normal type. It has been named the Stewart Cuban.

The normal Cuban seed which was saved in 1910 was again used for planting in 1913, and over 200 acres, or two and one half million plants, were grown. Although search was made at the Windsor Tobacco Growers' Corporation, which grows over 100 acres, no mutating plants were discovered. Two mutants were found at other plantations where the 1910 Windsor Corporation seed was used, which presented the same habit of producing a large leaf number. Thus, five similar mutants from the same seed have been discovered, though it can not be stated that they did not all come from a single normal plant. The frequency of the appearance of this mutation is at the rate of about one plant in a million.

This mutation must have taken place after fertilization, *i. e.*, after the union of the male and female reproductive cells. If the mutation had taken place in either the male or female cell before fertilization, the mutant would have been a first generation hybrid, and would have given a variable progeny the following season.

Mutations of high leaf number have been observed in tobacco previous to this time. Several years ago a variant with a large leaf number was found in the outdoor Havana type at the farm of Mr. Alsop in Avon, and in 1912 a Havana plant which bore 72 leaves was found at the Olds Brothers' Plantation in Bloomfield. Six similar mutations were found at a Windsor farm, and one at another farm in Bloomfield this last season. It is of interest to know that these mutations occurred in a variety, the Connecticut Havana, which has been grown in Connecticut for a period of over fifty years, and which is very uniform in habit. That it has been observed in different sections and by different growers shows that the same mutation must have taken place several times.

A similar type bearing a large leaf number appeared in Maryland several years ago, and is grown commercially under the name of Maryland Mammoth. The Maryland type was, however, the result of a cross between two Maryland tobacco varieties. The mutations which have occurred in Connecticut can hardly be explained on the basis of the results of a cross.

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REAL AND APPARENT NITRIFYING POWERS

In making bacteriological studies of soils one of the leading factors determined is the ability of the bacteria present to convert various forms of nitrogen into the nitrate condition. Comparison of this ability, as existing in different soils, is usually made under definite, more or less standard conditions. This factor is spoken of as the "nitrifying power" or "nitrifying efficiency."

Of recent years the tendency has been to employ the soil to be tested, or a standard soil, as the medium in which the organisms

shall work. An additional supply of nitrogen is usually furnished, either in the form of ammonium-sulphate, or some highly nitrogenous, easily decomposed, organic substance, such as cottonseed meal or tankage. Where soil has been employed as the medium, one of three methods of procedure has usually been followed. One method is to add to a definite weight of soil a given amount of nitrogen, incubate and then determine the quantity of nitrate nitrogen present. The amount found, taking no account of the nitrate nitrogen originally present, is regarded as indicating the comparative ability of different soil samples to form nitrate nitrogen from other forms of nitrogen; in other words, its nitrifying power—ability—efficiency. A second method is to make a determination of the amount of nitrate nitrogen present in a corresponding sample at the beginning of the experiment; otherwise proceed as above. The difference between the amount originally present and that found at the final analysis is regarded as the correct factor. By a third method duplicate samples are taken and treated exactly alike with the exception that only one receives an additional supply of nitrogen. After incubation both are analyzed and the difference in the nitrate nitrogen content is regarded as the correct factor for comparison.

Recently, in determining what Stevens and Withers have termed the nitrifying inoculating power of a series of plots that are under study, it became necessary to use a soil relatively high in nitrate nitrogen. Cottonseed meal was employed as the source of nitrogen. In a large number of cases, securing the comparative factor by either of the last two mentioned methods, it was found to be a minus quantity. That is, with the conditions optimum (so far as is known) for nitrification, the amount of nitrate nitrogen found after incubating was much less than originally present in the soil. If ammonium sulphate were substituted for cottonseed meal, as the source of nitrogen, such a condition was never noted. This led to a series of investigations to determine the cause of the minus factors that were secured. There were evidently losses of large quantities of nitrate nitrogen. Was this due to actual losses of total nitrogen or was the nitrate nitrogen merely transformed? To what extent does it occur? What are the conditions influencing the same? These are some of the questions an effort is being made to answer. Certain grave difficulties have thus far prevented a complete solution of the problems involved. However, it is believed that in the near future sufficient data, together with that upon which the statements herein presented are made, will be secured to completely settle the question.

One very interesting fact has been brought to light. This is that at least two of the methods now employed in bacteriological laboratories for determining the relative nitrifying power of soils may give us absolutely no indication of true values. The writer has abundant evidence to show that this is true in the presence of appreciable quantities of nitrate nitrogen when easily decomposed organic substances are employed as the source of nitrogen. Oft-repeated observations show that where from five to twenty-five mg. of NO_3 per 100 gr. soil is present and cottonseed meal added, at the end of seven days absolutely no trace of NO_3 can be found. If examined three weeks later an abundance will be present. According to the last two methods mentioned above, the five to twenty-five mg. NO_3 would be subtracted from that found at the final analysis and the difference taken as the factor indicating the amount formed during incubation. In reality, the amount present reached zero at one time, hence all found at the final analysis must have been formed during incubation, and represents more nearly the correct factor.

In a series of experiments designed for the purpose of determining how much NO_3 would disappear it was found that in five days in the presence of .95 gr. cottonseed meal, as high as thirty-five mg. NO_3 per 100 gr. soil had been lost. With 1.9 gr. cottonseed meal the quantity ran up to fifty-five mg. With higher quantities of cottonseed meal still larger amounts of NO_3 were lost. With

small quantities of cottonseed meal the nitrate nitrogen may begin to accumulate again after ten days' incubation. With larger quantities the time is longer. This fact has probably caused many to overlook the first disappearance.

Just what becomes of the nitrate nitrogen, under such conditions, has not been determined. There are two possibilities. It may be liberated in the elementary form through the process of denitrification. This seems improbable since the soil in the writer's experiments has never been much over an inch in depth and never more than two thirds saturated, hence aeration was good. Another possibility is that it may be assimilated. There is always a very copious growth of soil fungi of various forms when cottonseed meal is applied. In fact, so abundant are the mycelial threads that they bind the soil together in a mass which is rather difficult to disintegrate by the ordinary shaking method. It is highly probable that at least a portion of the nitrate nitrogen is assimilated by this growth. It would seem that it would be very easy to determine the above question, but the volatilization of ammonia where large amounts are being formed, as is always the case in the presence of cottonseed meal, makes it difficult.

It is evident, from what has just been said, that deducting the nitrate nitrogen originally present or that in an incubated check, will not give us correct results under the conditions mentioned above. The more nitrate nitrogen initially present, the less reliable will be our results. These two methods must then be abandoned. Simply taking as the correct factor the amount found at the final analysis will probably approach nearer the truth than any other method now in practise. However, we have no assurance that this gives us an accurate idea of the relative amount formed in different soils. There is absolutely no way of determining the actual amount formed that immediately disappears. We only know that in this method the actual amount present at one time (unless very large amounts were initially present) was zero, and that all formed at any future date must have been formed during the course of the experiment.

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ON THE APPARENT ABSENCE OF APOGAMY IN ŒNOTHERA

IN a previous note in SCIENCE[1] I described certain experiments which suggested that *Œnothera* was occasionally apogamous. Three imperfect seeds were obtained from a castrated flower of *O.* mut. *lata,* suggesting the possibility that a small percentage of the seeds might develop apogamously. Last year (1912) the experiments were carried out more extensively, however, and the results were wholly negative, showing that if apogamy occurs in *O.* mut. *lata* it must be very rare indeed.

Six *lata* plants were experimented upon, whose history was as follows: one was a mutant appearing in a culture of a race of *O. Lamarckiana* from the Kolosvar Botanical Garden; two were derived from *lata* self-pollinated in the cultures of de Vries; two were mutants occurring in a *rubinervis*-like race obtained from Heribert-Nilsson in Sweden; and one was *O. biennis* mut. *lata* appearing in a race of *O. biennis* from the Madrid Botanical Garden. On these plants over 20 flowers were castrated and covered with bags during the height of the blooming season, from July 22 to August 13, 1912. In addition, a whole branch of one pollen-sterile *lata* plant, containing 20 flowers, was covered with a large bag. No growth of the capsules took place in any case, and not a single seed could be found in any of the capsules. It would appear, therefore, that under these circumstances at least, apogamous development practically never occurs in *lata,* for the number of ovules in the capsules observed must have numbered several thousands. The plants were, moreover, all well nourished.

Similar experiments made with eight flowers belonging to four plants of *O.* mut. *gigas* also

[1] Gates, R. R., "Apogamy in *Œnothera,*" SCIENCE, N. S. 30: 691–694, 1909.

gave wholly negative results, not a single seed developing. This race of *gigas* came from an independent source, having originated, apparently by a mutation, in the Palermo Botanical Garden.[2] Theoretically, it might have been anticipated that the eggs of these plants, having already the diploid number of chromosomes (14) would be most likely to show a tendency to apogamy, but so far as the evidence goes this does not appear to be the case. The unbalanced chromosome number (15) in *lata* might on the other hand perhaps be expected to predispose megaspores or egg cells of *lata* having this number of chromosomes (assuming that such occur) instead of the reduced number, to degeneration.

Nevertheless, from the observation by Geerts of a megaspore mother cell of *Lamarckiana* containing 28 chromosomes, and from the discovery, by Miss Lutz[3] and Stomps,[4] of triploid mutants containing 21 chromosomes, it seems quite certain that eggs containing 14 chromosomes must occasionally be formed in *Lamarckiana*. Why such cells might not develop embryos occasionally, even if unfertilized, is not clear, and perhaps an extensive series of experiments with *Lamarckiana* and some of its 14-chromosome derivatives may yet show that this type of apogamy sometimes occurs.

In the light of these facts it appears desirable that the experiments of Mrs. Rose Haig-Thomas[5] on apogamy in *O. biennis* be repeated before the results are accepted as facts.

I may add that I have very recently observed a case of parthenocarpy in a race of *O. muricata* L. from eastern Canada grown in my cultures this season. This culture contained only four plants, all alike. Earlier in the season normal capsules were produced filled with seeds, but the later capsules (observed November 19) though full size and with normally developed walls, were hollow, containing undeveloped ovules instead of seeds. It seems possible that the drop in temperature at the end of the season may have been sufficient to kill the young embryos shortly after the eggs were fertilized, while the capsule walls, already stimulated by the process of fertilization, continued their development. However, nothing of the kind was observed in any other race.

R. R. Gates

University of London

[2] Gates, R. R., "Tetraploid Mutants and Chromosome Mechanisms," *Biol. Centlbl.*, 33: 92–99, 113–150, Figs. 7, 1913.

[3] Lutz, Anne M., "Triploid Mutants in *Œnothera*," *Biol. Centlbl.*, 32: 385–435, Figs. 7, 1912.

[4] Stomps, Theo. J., "Mutation bei *Œnothera biennis* L.," *Biol. Centlbl.*, 32: 521–535, Pl. 1, Fig. 1, 1912.

[5] Haig-Thomas, Mrs. Rose, "Note sur la parthénogénèse chez les plantes," *Comptes Rendus*, IV° Conf. Intern. de Génétique, Paris, 1913, p. 209.

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

On November 7, before the American Philosophical Society, a paper was read by Professor J. M. Macfarlane on "The Phylogeny of Plants in Relation to their Environment." Recalling the conclusions already published in the centennial volume of the Academy of Natural Sciences, the speaker showed that, of the simplest non-nucleate plants the great majority seem to have had a thermal-water or fresh-water origin. Of the simpler nucleate plants, such as the Desmids, the Protococcoid, Pleurococcoid, Chætophoroid, Cladophoroid and related groups, all or the preponderating number were fresh-water. Even the simplest brown algæ like *Lithoderma*, *Pleurocladia* and *Heribaudiella* were now in part or wholly fresh-water, as were the simplest groups of the red algæ. An estimation of the genera and species of algæ and fungi now living revealed that 3,008 genera and about 28,660 species were fresh-water or land forms, 658 genera and 5,930 species were marine. Interesting data were advanced as to transition or brackish species. The phylogenetic origin of bryophytic, pteridophytic and higher classes from certain fresh-water algæ was advocated, while the extreme rarity of any genus of these classes in marine surroundings was emphasized. The speaker, therefore, concluded that marine life was probably derived from a thermal-water and later from a fresh-water source. Though contrary to the whole trend of zoological consideration, he indicated that in an abstract already published he had advocated a like origin in fresh water for animal as for plant life, and a derived distribution of many groups of animals into the sea.

SCIENCE

FRIDAY, JANUARY 9, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE THE ATLANTA MEETING

UNDER the presidency of Dr. Edmund B. Wilson, professor of zoology in Columbia University, the sixty-fifth meeting of the American Association for the Advancement of Science, and the twelfth of the "Convocation week" meetings, was held in Atlanta from December 29, 1913, to January 3, 1914.

It seems to be almost impossible to obtain an accurate record of the attendance, chiefly because the members of the affiliated societies do not register. The number actually registered at headquarters was 324 members of the association, 54 members of affiliated societies and 16 delegates. Perhaps the total attendance, based to be sure on estimation, was about 500, a very good number when one remembers that Atlanta is rather out of the beaten track of tourists, but even if the number in attendance was not as great as at some of the previous meetings, and notwithstanding the rainy weather, the admirable arrangements and the enthusiastic reception accorded were more than compensation. With that characteristic hospitality of the south the people of Atlanta extended to the visitors a welcome that will long be remembered.

The following affiliated societies met during the week:

Astronomical and Astrophysical Society of America.
Botanical Society of America.
American Association of Economic Entomologists.
Entomological Society of America.
American Microscopical Society.
American Physical Society.
American Phytopathological Association.
School Garden Association of America.
Southern Society for Philosophy and Psychology.

On Monday evening the association formally opened its convention by the general session in Taft Hall of the auditorium-armory building. The meeting was called to order by the retiring president, Dr. Edward C. Pickering, who introduced the president of the meeting, Dr. Edmund B. Wilson. If anything was needed to assure the association of its hearty welcome, surely the letter of greeting sent by Governor Slaton, and the address of Mayor Woodward amply sufficed. After President Wilson's reply, Dr. Pickering delivered the annual address on "The Study of the Stars." This meeting was preceded in a delightful way by an organ recital through the courtesy of the Atlanta Musical Festival Association, Mr. Chas. A. Sheldon, Jr., being the organist. After the meeting the members and visiting ladies were entertained by a reception at the University Club.

On Tuesday, from five to seven o'clock the visitors were received by Governor and Mrs. John M. Slaton at the governor's mansion.

Two evening lectures of the popular kind complimentary to the citizens of Atlanta were delivered. On Tuesday Dr. Chas. Wardell Stiles, of the U. S. Public Health Service, discussed "The Health of the Mother in the South," and on the following evening the subject of the lecture by Professor Chas. E. Munroe, of the George Washington University, was "The Explosive Resources of the Confederacy during the War and Now: A Chapter in Chemical History."

Numerous smokers, luncheons, and dinners and several excursions to near-by institutions and places of historical and scientific interest helped to add to the social pleasure of the week.

The different sections of the association and the affiliated societies met morning and afternoon for the reading of papers throughout the week or until the lists of titles were finished.

The vice-presidential addresses given before the sections were as follows:

Section A: "The Influence of Fourier's Series upon the Development of Mathematics," by Edward B. Van Vleck.

Section B: "The Methods of Science: To What do they Apply?" by Arthur G. Webster.

Section D: "Safety and the Prevention of Waste in Mining and Metallurgical Operations," by J. A. Holmes.

Section E: "Pleistocene History of Missouri River," by J. E. Todd.

Section F: "The Story of Human Lineage," by William A. Locy.

Section G: "The Evolution of a Botanical Problem," by Duncan S. Johnson.

Section I: "The Development of our Foreign Trade," by John Hays Hammond.

Section K: "The Physiological Instruction of Medical Students," by J. J. R. Macleod. (Read by title.)

Section L: "Science, Education and Democracy," by J. McKeen Cattell.

Among the more important actions taken by the Council, the following may be mentioned:

280 members and 200 fellows were elected.

On motion, the following resolutions offered by the committee on policy were adopted:

Resolved, That the council looks with favor upon the organization of a Brazilian division of the association, and that a committee on organization be appointed for this work with Senator Eduardo Braga as chairman.

Resolved, That the Society of American Foresters be formally accepted as an affiliated society.

Resolved, That the council of the American Association for the Advancement of Science authorizes the establishment of local branches of the association in places where the members are prepared to conduct branches which will forward the objects of the association.

Resolved, That the standing committee on organization and membership be instructed to promote the establishment of such local branches.

The associate secretary for the south made an interesting report of the work which he had undertaken towards stimulating an interest in the association in the south. He reported correspondence with several hundred men in southern institutions and a visit to several of the educational institutions of the south.

Dr. McDougal reported news concerning the Pacific Coast Division with reference to the Pacific Coast Meeting. A committee of thirty from this division has been given power to organize for the specific purpose of making preparations for this meeting. He also stated that the Pacific Coast Association of Scientific Societies, composed of three or four hundred members, had also taken this matter up. Members should come prepared to spend at least ten days in California, as meetings would probably be held in three or four different places in the state. The time of holding this meeting was discussed but no definite action taken.

Dr. Pickering and Dr. Holmes on behalf of the committee on expert testimony reported progress, but postponed its final report.

The permanent secretary read a letter from Dr. J. S. Diller, asking that a grant be made for the publication of the twenty-four papers read before Section E, on the Mineral Resources of the Southern States. On motion, a grant of $200 was appropriated for this purpose.

On motion, the permanent secretary and the editor of science were instructed to prepare a directory of the funds available for research work for the information of those desiring to make application for the same.

The president announced the members he had appointed on the committee of one hundred on research authorized at the spring meeting of the council.

On motion, a list of the members of the association, the constitution and the official proceedings were ordered printed during the year, and every three years thereafter, provided funds are available.

At the meeting of the general committee, the following officers were elected:

President: Chas. W. Eliot, president emeritus of Harvard University.

Vice-presidents:

Section A: Henry S. White, Vassar College.

Section B: Anthony Zeleny, University of Minnesota.

Section D: Albert Noble, New York.

Section E: U. S. Grant, Northwestern University.

Section F: Frank R. Lillie, University of Chicago.

Section G: G. P. Clinton, Connecticut Agricultural Experiment Station.

Section H: Clark Wissler, American Museum of Natural History.

Section K: R. M. Pearce, University of Pennsylvania.

Section L: Paul H. Hanus, Harvard University.

Section M: L. H. Bailey, Cornell University.

General Secretary: W. A. Worsham, Jr., Athens State College of Agriculture.

Secretary of Council: Henry Skinner, Academy of Sciences, Philadelphia

Associate Secretary of the South: R. M. Ogden, University of Tennessee.

At this meeting it was decided to hold the next meeting of the association at Philadelphia, during convocation week, 1914–1915.

On motion it was recommended to future general committees that the meeting of 1915–16 be held at Toronto and the meeting

of 1916–17 in New York. It was further recommended that the New York meeting be a special meeting in which all affiliated societies should be invited to take part and that such general convocation-week meetings should be held at intervals of four years, the second to be in Chicago in 1920–1921.

At its last meeting the council passed a resolution extending its warmest appreciation and thanks to the local committee, to the citizens of Atlanta and all those who contributed so ably and willingly to the comfort and entertainment of the members.

Atlanta has been called the metropolis of the "New South" and those visitors who found time to visit some of its many interesting places and institutions went away with new impressions that were not the least assets of a most enjoyable and successful meeting.

H. W. Springsteen,
General Secretary.

THE METHODS OF THE PHYSICAL SCIENCES. TO WHAT ARE THEY APPLICABLE?[1]

It is generally expected that a retiring vice-president shall deal in his retiring address with one of two things, either some aspects of his own work or some of the important questions which are agitating his own branch of science. My excuse for doing neither of these is that I do not feel that my own researches are of sufficient general interest for mention at this time, and that the masterly address of Professor Millikan last year on the theory of quanta had made it impossible for me to add anything to perhaps the most important of the recent new developments in physical theory. In deciding to content myself with some general observations I find that I have exposed myself to two risks, one that of repeating ideas that I have before expressed, the other that of seeming to have borrowed from the very interesting and fruitful address of Sir Oliver Lodge at the recent meeting of the British Association.

We physicists may certainly look with satisfaction at the present condition of our science, for although it finds itself in a period of violent flux involving the possibility of the discarding or modifying of some of our most cherished notions, it still remains as the model for the other sciences, many of which it logically includes in itself. When we speak of the methods of physical science, we of course mean the experimental method, as that is what distinguishes modern science from that of antiquity, but we include not only the methods and instruments of observation but also our methods of thought and reasoning. If we are to class sciences by the instruments used, we shall find most of them to belong under physics. Thus astronomy, so long confined to the study of the positions of the stars in two coordinates on the heavenly sphere, made use almost exclusively of the telescope and the clock, as important in the physical laboratory as in the observatory, while the modern part of astronomy annexes to the telescope the spectroscope and the photometer, the bolometer with its attendant galvanometer and the most recent developments of the physical laboratory in measuring radiation, including the recently discovered liberation of electrons from metals by light. For over a century chemistry has depended upon the physical balance as its chief instrument of measurement, while to-day the chemist uses the thermometer and calorimeter, the manometer for gas and osmotic pressures, and all the instruments for the measurement of electrical current and difference of potential that the physical labo-

[1] Address of the vice-president and chairman of Section B—Physics—American Association for the Advancement of Science, Atlanta, December, 1913.

ratory can afford him. As for meteorology or cosmical physics, it has no instruments except those of the physical laboratory.

But even outside of the purely physical sciences, we see the application of their methods of experimentation. In the physiological laboratory we find not only thermometers, but accurate manometers for the measurement of the blood pressure, and registering instruments for all the rhythms of the various organs and the study of fatigue, with electroscopes and galvanometers for the study of the electrical phenomena connected with the nerves and muscles. In fact the fertile brain of the physiologist Einthoven has given back to the physicist the most sensitive galvanometer that he possesses in the beautiful string-galvanometer which is used to study the action of the heart by means of the electric currents connected with its beating.

The science of botany is one that in many of its methods seems very remote from physics, and the work of the systematic botanist whose main interest seems to be to collect and label different plants and file them away in herbaria seems the antipodes of the methods of the physicist. And yet we have now the subject of plant physiology, in the laboratories of which we see again the familiar physical instruments in new applications. But recently in such a laboratory I saw an artificial tree, constructed of glass tubes and porous porcelain, which raised water from a reservoir and evaporated it into the air in close imitation of a real tree. Here again the thermometer and hygrometer are of prime importance, while we may expect the calorimeter, which has become so very important in physiology in connection with nutrition, to play its part in botany as well. It is of interest to find that the direction of the vertical, which seems to be so important in connection with the growth of plants, is not mysterious, but that if the plant is subjected to centripetal acceleration in a whirling machine, its root will yield exactly as to gravity. Finally we must credit to botany the study of osmotic pressure, the laws of which as discovered by Pfeffer have opened an enormous field to the physicist and chemist.

Finally invading the domain of the mental sciences, we find in the laboratory of experimental psychology, which may be variously termed physiological psychology or psychophysics, the same physical instrument and new ways of applying them. However color is interpreted to the brain by means of the physical and physiological mechanism of the eye, its physical properties must be definitely determined before any progress can be made. Similarly the sense of hearing can not be examined with definiteness until physical standards of sound are forthcoming. The slight advance made in the study of the sense of smell is probably due to the lack of its specification in chemical or physical terms. And the favorite subject of study in this field, that of the time of transmission of nerve impulses or of the formation of judgments, depends on the most fundamental of physical instruments, the clock.

But it would be tedious, as well as unnecessary, to attempt to enumerate all the instruments that have been contributed to the other sciences by physics. Let us turn to the methods of investigation which have proved characteristic of physical science. The collection of examples of phenomena, and their arrangement in classes, is of course characteristic of all the sciences, of botany or of anthropology as of physics. But the essential idea in classification in physics is the quantitative method, which results in methods of measurement, and the invention of instruments for their performance. After this has become possible, the next step is to formulate a theory, which may be of two kinds, either an ex-

planation of the phenomena by means of simpler and more familiar phenomena, or what is more likely to be possible, a theory which is the mere description of the phenomena mathematically in quantitative terms. For example, perhaps the first natural phenomena to be observed were those connected with the recurrence of day and night, the seasons, and the weather. But how long was it before the simple hypothesis was formed of the rotation of the earth, to say nothing of its orbital motion around the sun! And until clocks were invented no very profound conclusions as to the constancy of the length of the day or year were possible. That the properties of space and time might be discussed by philosophers was to be sure possible, but their results would not carry great weight with the new school of natural philosophers. When Galileo deduced by experiment, and described with mathematical precision, the acceleration of a falling body, he probably contributed more to the physical sciences than all the philosophers who had preceded him.

The investigation of physical phenomena has been a most fertile source of improvement of mathematical methods, but this to me most alluring subject I have no time to develop, having treated it at length elsewhere.[1] Of this the most notable example is Newton's invention of the differential and integral calculus, which has given us probably the most powerful instrument devised by man for making discoveries. Without it no progress could have been made in the examination of continuously varying phenomena. Is nature continuous or not, that is, in the neighborhood of every point of space within a distance no matter how small, are there as many other points as we please, and may a similar statement be made for time? Is matter continuous, and do all varying quantities vary continuously? This I do not intend to discuss, referring you to Sir Oliver Lodge, who took that for his subject. But whether nature is continuous or not, it is extremely convenient to postulate that it is so. We are thus enabled to describe phenomena by means of differential equations, explaining or describing what happens at any point of space and time in terms of what is happening at the infinitely near ones. This has been then the most important of our ways of thinking about physical phenomena. For upon this we have based the method of dynamics, so auspiciously begun by Galileo and perfected by Newton. Galileo gave us the notion of acceleration, very important for a single body, but Newton completed it by that of force, which enables us to describe the actions of one body on another. Let me point out to you that what Newton did in connection with gravitation was not to explain it in the sense of telling what its cause is, but, as I have stated above, to describe it in exact mathematical terms. But, much more than this, Newton, by his succinct statement of the laws of motion, gave us the possibility of the explanation of a vast number of recondite phenomena in terms of the more familiar ones of dynamics.

The dynamical method then became the most important of physical methods of explanation. Here mathematics, by some thinkers considered, as Huxley said, to be "that science which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation," has rendered invaluable services. It is true that mathematics can not turn out more than is put in, but it can transform the data in a wonderful manner. Thus proceeding from Newton's definition of force, it led to the notion of energy, and eventually to the conception of the conservation

1 Presidential address, American Physical Society, *Physical Review*, 1904.

of energy. To be sure, the notion of energy could not become of universal application until justified by multifarious experiment, and yet this has now come to be a principle in which we have more confidence than any other, not only in physics, but in all the natural sciences. But the principle of energy is not the only generalization of mechanics, nor in fact is it sufficient for the establishment of the equations of mechanics. A more general one is found in the so-called principle of least action, established upon a secure basis by Hamilton. From this principle all that we know of dynamics can be deduced, and by dynamics thus defined all the phenomena of celestial mechanics can be explained, with an accuracy almost beyond belief, the single law of the inverse square sufficing for all heavenly phenomena with an accuracy probably beyond that of our description of anything else in nature.

As one of the triumphs of the dynamical method in the explanation of recondite phenomena must be mentioned Maxwell's theory of the electromagnetic field, leading him to the discovery of the electromagnetic nature of light, and the prediction of electromagnetic waves. But in spite of this and other triumphs, the dynamical method alone was not sufficient in many cases.

Chemistry remained intractable by its means, and all the phenomena involving heat seemed outside its range. But it was at this very point that a powerful addition to the dynamical method came to its aid. As remarked above, the principle of conservation of energy would not have become so intrenched had it not been for its experimental confirmation, especially in the domain of the relations between heat and work, as carried out by Joule. The principle of equivalence, which has since been considered as the first law of thermodynamics, then, extended the dynamical generalization to a far larger field, and explained the disappearance of dynamical energy by its reappearance in the form of heat. But even then certain phenomena remained intractable by dynamical means, such as the well-known phenomena of heat conduction. To turn aside for a moment, the treatment of heat conduction by Fourier furnishes an admirable example of a merely descriptive theory, in which everything is exactly described, but it is of no moment for the theory whether heat is a fluid substance, a form of energy or an agitation of molecules. The laws of flow of heat, although merely descriptive, by analogy led to other great generalizations, notably in connection with the flow of electricity and with magnetism and electrostatics.

The method of analogy, always an attractive but dangerous one, led in connection with heat to a generalization which led to possibilities that dynamics could not furnish. The analogy of the working of water in a mill by falling from a higher to a lower level led Carnot to a conclusion, which though based on an imperfect analogy, led to most important results regarding the possibility of thermal changes. From his statement regarding the efficiency of heat engines, as based upon the fall in temperature of the heat employed, has resulted the second law of thermodynamics, or the principle of entropy, which together with the principle of energy has given us a method of enormous power, which may be indeed extended to those sciences toward which the dynamical method has shown itself as yet powerless. It was to the methods of thermodynamics that chemistry was destined to yield, largely through the efforts of our countryman, Willard Gibbs, and of Helmholtz. The reason for the failure of dynamics alone in chemistry may be stated as follows. The method of dynamics requires the complete specification of a system

in terms of a certain number of variable parameters, in terms of which two energy functions may be formed, one involving both the parameters and their velocities of change, and called kinetic energy, the other the parameters themselves only, and called potential energy. Now since we can not see the atoms or molecules, and do not know how they move, we can not form these energy functions, and hence can not form the differential equations. But by means of the principle of equivalence, we may determine the *sum* of the energies, by allowing them to be transformed into heat, and measuring this in a calorimeter. For this purpose we have the valuable thermochemical material of Julius Thomsen and others. But later other methods were devised of holding chemical reactions in equilibrium, and making them go in either direction reversibly. For instance, a salt, which would dissolve in water or an acid with the emission of heat, could in an electrolytic cell, to which a balancing electromotive force is applied, be dissolved or removed from the solution. By distillation the salt could also be removed from the solution, while the use of the semipermeable diaphragm and the methods of osmotic pressure introduced by van 't Hoff furnished a variety of methods for the calculation of the energy involved, and the separation of it into two factors, one analogous to a force and the other to a displacement, leading to the definition of chemical affinities. This necessary step being taken, and Rayleigh and Gibbs having shown how the entropy could be computed, the methods of thermodynamics became applicable, and chemistry came under the domain of mathematical treatment.

During all this time the question had been many times asked whether the second law of thermodynamics and the properties of entropy could not be deduced from purely dynamical principles, so that thermodynamics should be brought under the classification of dynamics. To this question a negative answer had always been returned, although Helmholtz had described a certain sort of system for which the law of entropy applied. It was not until the development of a new method in physics, which though using the principles of pure dynamics, went much farther, that this end seemed to be attained. This was the so-called statistical method, which becomes every day more important, and may sooner or later supersede some of our classical methods involving differential equations. The first example of this was afforded by the kinetic theory of gases, in which the properties of a gas were explained by considering it to be instead of a continuous body, an aggregation of a huge number of small similar molecules, moving about with great velocities in all directions, and by their impacts on each other and the sides of the containing vessel causing the pressure. It was at first the custom to treat them as if moving all with a common velocity, the directions being distributed at random, but to Maxwell occurred the happy idea of applying the principles of probability or statistics, the method namely of averaging up the actions of a great number of individuals of which we know little or nothing singly. For instance, we know nothing of the direction or magnitude of the velocity of any particular molecule, nor of the direction joining the line of centers of two colliding molecules, but we may assume, since we know nothing to the contrary, that all velocities and directions are represented, and that there are fewer individuals possessing very large or very small velocities than those having some mean velocity. The only laws of mechanics made use of were that between impacts the velocity of a particle was constant, and that in each impact the momentum and energy

were conserved. The important thing then was the application of the laws of probability, and by this means Maxwell was led to show that in a steady state, that is, one independent of the time, the velocities were distributed according to the so-called law of errors. As this law is so important, permit me to give the familiar example which illustrates the main points of the discussion. Suppose we have a vertical board into which are driven a large number of horizontal pins regularly arranged in symmetrical diagonal lines. If now we allow shot to fall from a funnel above the middle of the board, a shot striking any pin will fall either to the right or the left. Of course the circumstances will, according to the laws of dynamics, determine in each particular case which way it will fall, but if we know nothing more about them we can only assume that it is equally likely to fall either way. The next time it strikes the same thing is the case, and the question arises what will be the effect of a great number of similar causes each equally likely to act one way or the other. The answer is simple. Evidently there will be more shot that will fall directly below than toward either side, and the distribution will be symmetrical on both sides, falling off to nothing at great distances. If we should find that the distribution was unsymmetrical we should immediately infer that there was something unfair about the apparatus, for instance, the pegs were different on one side from the other.

Let me here diverge for a moment to point out that here is a method which is as applicable to biological phenomena as to dynamics, and that by its means the resultant of a large number of causes acting at random may be investigated. The essential of the method is that one of two effects is held to be as likely as the other. If we consider a large number of similar objects, say beans or shells, measure their length or some characteristic feature, the different values will in general be distributed according to the law of errors. If not, our assumptions as to what is equally likely are not true. This statistical method is of the greatest use in anthropology and in the study of inheritance, now such an important part of biological study. It is true that the biologist may object that this method is a purely mathematical one, and is not borrowed from physics. This I shall not stop to discuss, merely pointing out where the same method is applicable to both physical and biological phenomena.

To return then to the application of statistical methods to dynamics. Besides the law of distribution of velocities, Maxwell was able to show that if molecules of two or more kinds were admitted to the same space then when statistical equilibrium was attained the mean kinetic energy of the different types of molecules would be the same, thus leading to a dynamical explanation of the law of Avogadro, one of the most important of chemical laws. Boltzmann, taking up the subject at this point, pushed the generalization of Maxwell farther, and applied it to individuals each more complicated than the simple molecule, and was able to show how a system not in statistical equilibrium tends to approach that condition. Furthermore, he defines a certain function of the state of distribution which continually tends to increase, thus having the same property as the entropy of a system. Thus for the first time we get an explanation of entropy, which dynamics alone failed to give, by means of statistical dynamics or probability.

Perhaps the most striking triumph of the statistical method has been its application to the theory of radiation from a hot body, which has been successfully worked out in the last decade, through the endeav-

ors of Lord Rayleigh, Wien, and particularly Max Planck. In order to explain the dependence of the distribution of energy in the spectrum upon the temperature of the radiating body Planck was led to consider the emission of energy from a large number of electrical oscillators, which from their power of absorption of energy may be also described as resonators. In order to find the entropy to be associated with these resonators by an application of Boltzmann's definition as a probability, and to define what is equally likely as to the amount of energy possessed by the individual resonators Planck found it necessary to assume that this amount of energy could not vary continuously, but must be an integral multiple of a certain very small amount which has been termed the elementary *quantum* of energy. The results of this quantum hypothesis of the atomic nature of energy has been to send a sort of earthquake shock through some of the foundations of physical theory, and we can not yet judge of the ultimate outcome. These matters were handled so thoroughly by my predecessor that I do not need to do more than mention their importance.

I have thus mentioned as the chief methods of physical investigation the method of pure dynamics, that of thermodynamics and that of the statistical method. I may add the method of which I have given an example, that of simple analogy, without the backing of any definite hypothesis. I have spoken of Carnot's successful use of this plan, also of Ohm's law as the analogy of Fourier's. A further example is found in the case of chemical reaction-velocities. Without making exact dynamical assumptions, in many cases it is sufficient to assume that the velocity of a reaction is proportional, like that of a pendulum moving in a highly resisting medium, to the distance yet to go to reach equilibrium, that is, to the amount of substance that has not yet reacted. We thus get an approach to completion proportional to an exponential function of the time. This exponential is of so frequent occurrence in all parts of nature that the reason for it is often overlooked and we see amusing instances of its rediscovery. It seems likely that this method of analogy, perhaps in this very example, may be of considerable application in biology. Suppose for instance, a portion of jelly inoculated by a needle with a certain bacillus. If the jelly is physically and chemically homogeneous the colony will grow at such a regular rate and with such a symmetrical form that it seems as if a differential equation could be formed, and the analogy with diffusion is very strong. If we could express biological forces or tendencies as we now can chemical ones there is no doubt that we could make long strides in this direction. What is now the outlook for our other methods applied to biology? Where we have to do with a distinctly physical phenomenon such, for instance, as in the propagation of the pulse-wave through the arteries, we may use the methods of pure dynamics. Or where we have to do with the conduction of the electrical current through the tissues we may use the known laws of electricity. But in connection with most of the phenomena of life we are far from having a sufficiently exact notion of the phenomena to apply dynamical principles. On the other hand, the method of thermodynamics may be of great use. No one, I suppose, doubts that the first law of thermodynamics is applicable to all physiological phenomena, both animal and vegetable. Whether it may be extended to mental phenomena is not so certain, and can not be settled until we are able to measure the amount of energy in mental processes. Certain experiments seem to show that we are near to this, and

yet I fancy that no psychologist will yet undertake to measure the relative amounts of energy involved in the composition of poetry, the translation from Greek or German, or the integration of a differential equation. Whether we believe with Mr. Arthur Balfour that "life and beauty and happiness are not measurable" or not, we are still far from having even proposed any units for their measurement.

The question whether the second law of thermodynamics is applicable to biological processes is an interesting one, and we may hope that it will some time be answered, but at present there seems to be great difficulty in defining entropy in connection with such processes. Until this at least can be done, we seem to be a long way from what seems to be the hope of many biologists to reduce the explanation of life to physics and chemistry. While I suppose that most of us believe, with Professor E. A. Schäfer, as stated in his British Association address of last year, that "the problems of life are essentially problems of matter; we can not conceive of life in the scientific sense as existing apart from matter. The phenomena of life are investigated, and can only be investigated, by the same methods as all other phenomena of matter, and the general results of such investigations tend to show that living beings are governed by laws identical with those which govern inanimate matter," while I say, most of us are willing to go so far, I presume that there are few physicists or chemists who will deny that there is probably some additional element involved in life, or who are willing to follow Professor Schäfer in his statement that "The combination of . . . these elements into a colloidal compound represents the chemical basis of life; and when the chemist succeeds in building up this compound it will without doubt be found to exhibit the phenomena which we are in the habit of associating with the term 'life.'" For if we can not answer the very direct questions that I have stated above how near are we to the position of certainty indicated by Professor Schäfer's words?

If the methods of dynamics and thermodynamics are not of present application in physiological processes, it is fair to suppose that they are even less so in connection with mental processes. That the statistical method is of value here however may be shown by consulting almost any psychological journal. A recent example is to the point. Many persons have the belief that they can tell when they are being stared at by a person whom they can not see. In order to test this subjects were placed under identical circumstances and an experimenter stared, or did not stare, as determined by the fall of a die, for a certain length of time, after which the subject reported on the result, without being informed of the true state of affairs. The guesses were then averaged, and the correct result having been arrived at in 50.2 per cent. of the trials, it was concluded that nothing more than pure chance had been in operation, and that the belief in the assumed ability is an error. What could be more like the examination of a physical phenomenon, and what more convincing? In the same manner we might examine the question of thought transference in general. The interest which the general public has in such investigations, and the desire that they be connected with physical phenomena, is illustrated by the incident of the publication, a few years ago, by a distinguished naturalist, of an obviously jocular account of "The Astral Camera Club of Alcalde," in which the formation of an actual image on the retina of a cat by thought transference was described with such particularity as to deceive so

many readers that an apology and explanation had to be published. What then shall we say of the attempt to push investigations into phenomena supposed not to originate in the world of matter, but in another world of whose existence we have as yet little knowledge, to put it mildly. Only that not only the general public is profoundly interested in the matter, but that eminent scientists, including astronomers, physicists and chemists of renown, have thought such investigations worth their attention, and have even declared themselves to have obtained results worthy of credence.

But how far are we justified in going in this direction? The objects of investigation in the physical sciences are manifold. In many cases we can control the phenomena to be observed, isolating them from disturbances, controlling the temperature, pressure, and other elements, and making the changes repeat at will. In other cases we can exercise no control, and yet the phenomena repeat themselves with periodic regularity, and can be observed at pleasure, as in the case of astronomical phenomena or the tides. In other cases the phenomena come at unknown times, irregularly, and we can observe them only by being prepared, as in the case of meteorological phenomena and earthquakes. But in all these cases there are definite phenomena, which we agree do exist, and which affect matter so as to be perceptible by instruments. But when we do not know whether phenomena exist or not how shall we investigate them? How easy it is for the layman to say, "We know that electromagnetic waves are transmitted through the ether, which we can not perceive by the senses, why should not waves be emitted by the brain, and be similarly transmitted through the ether?" Why indeed! We may answer him that even if we know nothing more of the ether than the speed of waves through it we know that extremely well, and that whether or not we know the mechanism of these waves (as I conceive we do) we at least know their differential equations, that is, the mode of their transmission. Moreover we have many instruments which are affected by these waves, whereas no one has ever managed, by means of thought waves, to affect the most sensitive instrument, whether torsion balance, quartz fiber, electrometer or galvanometer. When by taking thought, a mind in this world or the next, shall produce the smallest deflection in an instrument at a distance, then we shall be within the means of physical investigation. But, says the enthusiast, perhaps these waves, being not of physical but of mental origin, may be receivable not by physical, but only by mental apparatus, and may work only directly on the resonators of the brain. Very well, let us begin with the phenomena that we can control. It is easy to emit brain waves, if such there be. The method described above is then applicable. But if we are in the region of seismic mental waves, there is nothing to do but have our mental resonators always in adjustment and attuned. Then will come the difficulty of discriminating between "strays" and real receptions. How great this difficulty is is shown by the almost vanishingly small results of the societies for psychical research, so-called, and by the delusions from which reputable scientists have suffered. We may here mention the investigations on the celebrated Eusapia Paladino, who certainly secured good endorsements in Europe, but when brought here and examined by a committee including psychologists, physicists, and other detectives, was found to be explicable by purely physical hypotheses.

It is beyond my purpose to speak of the relations of science to religion and theol-

ogy, if indeed it has any such relations. But I can not resist recalling the scorn with which, in my boyhood, I remember hearing the minister describe Tyndall's famous proposed "prayer-test." I am free to say that I can not at present see why such a proposal should have created such a storm. If people actually believe in the existence of God, and that in addition he does grant requests addressed to him by persons of suitable character, what could be more suitable for decision by the statistical method than such a simple question? Fortunately times have changed, and the nature of prayer is now supposed to be quite otherwise, and to have its beneficent effect by reaction on the emitter, quite irrespective of its treatment at the receiving station. Nothing is more striking than the varying attitudes of scientists toward the subject of theology and religion, from the simple faith of a Faraday, Maxwell or Kelvin to the quite different attitude of a Tyndal, Huxley, or Haeckel. I take this to be due to the difficulty of defining the meaning of the theological terms, and to hazard the opinion that if we could define them even as well as we can entropy we should be found not to disagree profoundly. If it be true that "the undevout astronomer is mad," it is true because we admit that the chief effect of the pursuit of science is to give us a profound admiration for the workings of nature, together with the conviction that its methods are beautiful, definite and simple, and are capable of being understood by the human mind. If this is to say that they thus show evidence of having been designed by a great intelligence, like the human, but enormously more powerful, very well, but it is at this point that we begin to differ as to the meaning of our terms. The chief thing that the scientist should have learned is the possibility of his being mistaken, and the danger of denying in cases where he has no evidence. We must therefore conclude that while the methods of physical science have a continually widening field of application, we must advise him who asks the profoundly interesting question, "If a man die, shall he live again," to seek to answer it by other methods, *if he can.*

ARTHUR GORDON WEBSTER

THE TEACHING OF PHYSIOLOGY TO MEDICAL STUDENTS[1]

IN no way is the relative importance of physiology in the medical curriculum better attested than it is by the designation of "the Institutes of Medicine," under which it still appears in the catalogues of some of the older universities. Originating as a division of anatomy, physiology gradually assumed such importance in the medical curriculum as to necessitate the creation of an independent department, although for long the close relationship of the two subjects was maintained on account of the fact that conclusions regarding function had in large part to be inferred from an accurate knowledge of structure. It is for this reason that the study of the microscopic structure of the tissues was, and in some schools still is, assigned to the physiologist, and it is indeed only within comparatively recent years that there has been anything like a general change in the nature of the practical work which the student must do in his course in physiology.

As it now stands, physiology is generally defined as being the study of the phenomena of living things. "It deals with the process of life." It has nothing to do with the structure or morphology of dead things, although obviously a sound knowledge of this must be acquired before any attempt

[1] Address of the vice-president and chairman of Section K, Physiology and Experimental Medicine, Atlanta, Ga., December, 1913.

can be made to explain the functioning of the parts. Physiology, in short, must concern itself with an application of the known laws of physical and chemical science to the process of living in both plants and animals. It must, for example, endeavor to show whether the facts known to the chemist can be made available to explain the synthesis of the various constituents of plants, and the liberation of energy which follows the ingestion of these foodstuffs in animals; it must ascertain whether the movements of a muscle, the secretion of a gland, the transmission of a nerve impulse, are adequately accounted for by the known laws of physics, or whether there exists in living things some force that entirely alters or entirely obscures the physical process.

As thus defined, the science of physiology is obviously too wide in scope, and its ramifications too diversified, to make possible its inclusion as a subject in the medical curriculum. It must be delimited. For this purpose, the object aimed at is of course a knowledge of the functioning of the human animal, although in gaining this we must constantly endeavor to show, by observations on the lower animals, how the same general laws of function apply throughout the animal world. We must, above all things, treat the subject from a broad scientific point of view, not narrowing it down to a mere study of the complicated mechanism of the higher mammalia, but making it a general study of the essential nature of the life processes. Just in so far as the knowledge of physiology is sound will the practise of the physician be likely to be proficient.

For the medical student, therefore, physiology must serve as the connecting link between his pre-medical scientific studies and the clinical work which is to follow. It must be considered as the center to which the basic sciences converge, and from which diverge the various subjects that are related to the study of disease.

A knowledge of physics, chemistry and morphological biology constitutes the bedrock upon which the foundation of medical knowledge, represented by physiology, must be built, and it is only after the foundation is completed that it becomes possible to add the superstructure which is represented by pharmacology, experimental pathology, hygiene and medicine. Physiology bears to medicine much the same relationship that anatomy bears to surgery, for the physiologist of to-day is the physician of to-morrow, just as the anatomist of to-day is the surgeon of to-morrow.

The objects which must be kept in view in framing the course in physiology for medical students may therefore be stated as being: (1) a knowledge of the application of the known laws of physics and chemistry in living things; (2) a knowledge of the behavior of those life processes which can not at present be explained on a physico-chemical basis. To impart such knowledge, we must, in the first place, offer the student ample opportunity for the direct observation of the behavior of living things, so that his knowledge of physiology may rest upon a basis of personal observation rather than upon one of authority. The student must, above all things, be trained to be an investigator of the behavior of living things, and he must be constantly reminded that the observations which he makes on the normal animal are later to serve him as a standard with which to compare the behavior of the disturbed functions in disease. But practical courses alone will not suffice. They must be supplemented by didactic instruction of such a nature as to show the student how the facts which he himself gathers from direct observation can be linked together with one another and with those of other investiga-

tors, so as to form a connected account of the working of living things.

As to the actual pedagogical methods by which we are to fulfill these requirements, it will be convenient to consider, first, the practical, and secondly, the didactic instruction. A thorough training in the methods of accurate observation, as applied to living things, must be the first step in the physiology course, for even granted that the student may have graduated in experimental physics, it will still be necessary for him to become familiar with methods by which to control and simplify the variable and complicated factor that the existence of a living tissue now introduces into his experiment. The experiment in physics is one in which everything is more or less controllable, a result once obtained being readily repeated; whereas in physiology a disturbing element is constantly present, for the physiological properties of the living object, whose movement or other function we are examining, may alter from time to time on account of vital processes over which we may not have any known means of control.

There are, I believe, no physiological experiments more suitable for this preliminary teaching than those on the nerve-muscle preparation of the frog. The actual physiological truths which the student may learn by doing these experiments are certainly not of much importance, at least from the medical standpoint, but the facility in accurate experimentation which he thereby acquires, as well as the ability to use his results for inductively drawing general conclusions, is essential to his further progress.

There is one other feature of these experiments that is of great value from the pedagogical standpoint, namely, the possibility of grading them with regard to complexity. In a few weeks the experiment may pass from the recording on a stationary drum of the degree of muscular contraction resulting from electric stimuli of varying strengths to the determination of the rate of transmission of an impulse along a nerve. When the student has acquired such technical facility that he can repeatedly obtain the same results in this experiment, he may be considered as competent to proceed with the more complicated experiments necessary to elucidate the fundamental truths of physiology.

The experiments on nerve-muscle being thus largely of a preliminary nature, the time occupied by them should not be unduly prolonged; sixteen sessions of two hours each are certainly adequate.

From such work to the study of the heart-beat in frogs and turtles is a natural step, the experimental technique being much the same, but greater care being demanded in the handling of the object under investigation. But another element now enters into the work, for the conclusions which may be drawn from the experiment come to be of great importance in themselves, and fundamental physiological truths concerning the nature of the heart-beat begin to unfold themselves to the observing student. He begins to feel that he is building up his fund of physiological knowledge at first hand, and he gradually comes to take a real interest in finding out, by consultation with his text-books, to what extent his observations and conclusions conform with those that are generally accepted. To encourage the spirit of independent investigation, and to add interest to the work, it is advisable, after a sufficient number of experiments has been performed, to devote a session or so of the class to a symposium in which the results obtained in the experimental work are collated and their significance discussed. For this purpose, each student should be required to prepare in

essay form a review of his findings, which he may be called upon to read before the class, and which is then discussed by the other students, with the object of bringing out the variations that occur, and of emphasizing the chief conclusions.

The time allowed for these experiments should be about one half of that occupied by the preliminary nerve-muscle work.

The student may now proceed to the experimental work on mammals, beginning with such problems as the control of blood pressure, the mass movement of blood, and other circulatory problems, and then proceeding with those pertaining to the respiratory, digestive, excretory and nervous systems. It is in the conduction of this course that the greatest pedagogic skill is demanded, for the experiments must be most carefully chosen so that their results may bring to light fundamental principles, and so that there may not be unnecessary repetition. The animals employed must be deeply anesthetized, and there must be sufficient competent oversight to make certain that at no stage do any of them show the least signs of consciousness. The animals must of course be killed at the termination of the experiment.

The question is sometimes asked as to whether it is necessary for the efficient training of medical students that they should participate in mammalian experiments. In my judgment, the question is as absurd as if it concerned the practical training of engineers. To drive our locomotives we do not employ men who have merely learned the theory of engine construction; we demand such as have gradually acquired a practical knowledge by actual experience.

It is obviously unnecessary that every student of the class should perform each experiment by himself; groups, composed of four or five students, should be formed, care being taken that the particular duties of the various members are so controlled by rotation that each has an opportunity during the course of actually taking part in every technical detail of the experiment. There should also be a sufficiency of trained instructors so that there is approximately one of these for every two groups. Conducted in this way, the experiments come to assume in part the nature of demonstrations, but they are of immensely greater value than the older lecture-table demonstration, because each student, by being an active participator in the work, comes to take a very much greater interest in the bearing of the experiment, besides acquiring greater operative and technical facility, which will be invaluable to him in his subsequent clinical work.

There are some persons who would doubt the necessity of even demonstrating any mammalian experiments to medical students. They maintain that it is unnecessary to repeat observations that have already been satisfactorily made and recorded. But if this were true for physiology, it must obviously also be true for physics and chemistry. According to those persons, there could be no value in *any* practical work in the pre-medical sciences, which would mean that the student on entering the wards would be no more familiar with the methods which are at his disposal for the accurate investigation of disease than would be a student of theology or law. When we bear in mind, however, that a patient with a disturbed blood circulation is strictly the same from the pathological standpoint as an anesthetized animal with corresponding conditions produced experimentally, we see how unreasonable such a contention comes to be. Is it better to have the student learn how to control a breakdown in the circulation on the patient or on the anesthetized animal? It is pos-

sible in a comparatively brief period of time to make the student of physiology acquainted with the fundamental conditions which disturb the circulation of the blood, for he creates the disturbance at will; it would take years to show him the same things on patients, because the lesions must be taken at random as the cases present themselves in the clinic.

It has been asserted that the mammalian experiments at least should be merely demonstrated to the students and that they themselves should not be called upon to participate in them. It has been pointed out, for example, that the fact that two loads are of equal weight is no more convincingly demonstrated by one's actually placing the loads on the scale pans of the balance than by seeing this done by another person. But the difference between this and a physiological experiment is very very great, and furnishes the very reason for which the latter should be performed by the student himself. For this difference depends on the fact that we are dealing with living processes that may materially alter the result of the experiment unless they are adequately controlled; to learn how to control them is one of the most important things that the student of medicine can learn. It would go beyond the scope of this article to present other arguments for or against the inclusion of practical work on mammals in the physiology course, but there is one pedagogical criticism that sometimes is made against the experiments that should be taken notice of. This refers to the possibility that the student may lose sight of the object for which the experiment is being performed on account of the attention which he must give in order to overcome the technical difficulties which it involves. This is undoubtedly likely to be the case unless great care is taken to have each experiment preceded by a conference, and, after several have been performed, to have the results reported and discussed in seminars. It is true that it may not be possible for the student immediately to correlate and place their full meaning on the experimental results which he obtains, and for this reason the teacher should as frequently as possible refer to these results in illustration of the principles which he is endeavoring to unfold in the didactic courses. Ultimately, however, the observations which he himself has made come to furnish the mainstay of the student's physiological knowledge, and he uses them as the basis for his further development.

Eight to ten sessions of four hours each are required for the mammalian experiments, after which several sessions are occupied in making accurate observations on the physiological functions of normal men, one student in each group serving in turn as the subject of investigation. In recent years the methods available for studies of this nature have very materially multiplied, indeed have done so to such an extent that several of the fundamental principles of physiology can now be as adequately demonstrated on man as by experiments on the lower animals. This permits of a certain amount of displacement of the experiments on anesthetized animals, an object which, for various reasons, should always be kept in view.

Coming now to the place of the didactic instruction, it may in general be stated that this should be so arranged as to supplement the practical. The lecture and recitation are certainly as indispensable as the practical class, for in them the principles of physiology—the institutes of medicine—must be expounded in logical sequence, and, as has already been stated, the bearing of the experiments which the students themselves have performed must

be clearly explained. It is in the lecture that an enthusiasm for the work may be instilled in the student's mind, and it is important that too much weight be not placed on detail, but that every opportunity be taken to show the application of physiological truths in the practise of medicine. For details the student should be referred to the text-books. It is often stated as an objection to systematic lectures that the students come to depend upon the notes which they succeed in taking during them in preparing for their examinations. To offset this possible tendency, there are two other features of didactic instruction which are of great importance. The one is the recitation or quiz, and the other, the symposium. One recitation should follow every two lectures, and it should be conducted, not by the lecturer himself, but by an assistant, who, although using a general outline of the lectures as his basis for questions, does not keep to that alone, but reviews the subject from his own point of view. It is important that a record be kept of the manner in which the questions are answered by each student, for otherwise it is difficult to hold every member of the class to thorough preparation. Review quizzes covering the larger subdivisions of the subject, such as circulation, respiration, etc., are also of great value.

The symposia constitute a most important feature of the course. Besides the symposia on practical work, which have already been discussed, there should be literary symposia, or journal-club meetings, in which each student in turn is required to read before the class a short paper compiled from the literature on some theme which has been allotted to him by ballot. The themes must be carefully chosen, so as to permit of presentation within the short time which is available for such work, and so that there is adequate representation in the English and American journals. Some students may be given themes requiring consultation of German or French journals, but in our experience the college training in modern languages is inadequate for their extended use in this way.

A general discussion, by the members of the class and by the instructor, should follow the presentation of each paper, the paper and discussion together occupying twenty minutes, thus permitting three papers to be presented in an hour. It is advantageous so to group the papers that the themes discussed during each symposium are closely related, for by doing so a much greater interest is likely to be aroused than if non-related subjects are presented. To prepare, even for the simplest of themes, a well-balanced and comprehensive review of the literature that shall occupy but ten minutes to present, is certainly by no means an easy task, not alone for beginners, but it is impressed upon the students that the practise which they get in attempting to do it will be invaluable to them when later, as practitioners of medicine, they desire to present papers at medical societies. Appropriate reprints of original articles can be lent from the department library to the students, but besides this they should have free access to such general reviews as the Index Medicus or the Surgeon General's Catalogue, the use and value of which they thus come to appreciate. In order to stimulate their best efforts, we have found it advantageous to offer to submit the best two or three papers for publication to the editor of the local medical journal. There should not be much difficulty in most large medical centers of finding some editor who would be glad to find room in his journal, at least during the summer months, for the publication of well-written, up-to-date reviews on

current physiological literature. A copy of each theme is placed in the department library, and its merit is taken into consideration in determining the final grade of the student.

Finally, at the very beginning of the physiological course there should be several lectures on general physiology, and at occasional periods during it there should be demonstrations by the instructors of more complicated experiments, which it would be impossible for the students themselves to perform.

Much has been written in recent times regarding the relationship of biochemistry to physiology, some believing that each subject should be assigned, like chemistry and physics, to separate departments, whereas others maintain that since physiology proper is the application of both chemistry and physics to the process of living, it should be taught by one who is more or less versed in both of these contributory sciences. In the present connection, our judgment is somewhat simplified by the fact that the question refers solely to the physiological training of medical students, to whom physiology must be taught because it is to serve as the foundation upon which is to be erected their subsequent knowledge of clinical medicine. It must be taught not in dissociated parts, but as an integrated assemblage of all the facts and observations from which its generalizations are induced. It does not matter very much whether the head of the department of physiology is primarily a chemist or a physicist. He should, however, be sufficiently familiar with both sciences to make it possible for him to teach the principles of physiology from both points of view, leaving detailed and practical instruction to associates who are specially trained in the purely experimental or in the purely chemical aspects of the subject. By such an arrangement, the professor of physiology in the medical school might be either an experimental or a chemical man, and his chief assistant would be especially qualified in whichever branch he himself was not so. Above all things, however, we believe that the two subjects should be taught together so that their interdependence may be constantly insisted upon.

Optional courses in special subjects, given by various members of the physiological staff, offer an important means for making the students cognizant of the nature of the research work which is going on in the physiological world. Although such courses are likely to be attended by the best students only, the class as a whole will come to realize that the department is alive and up-to-date, and that what they learn in the general course can represent but the very fundamentals of their science. The experience in teaching which the instructors gain by giving these optional courses is a further important reason for giving them. There is a growing opinion, and rightly so, we believe, that the experienced head man in the department should expend his energies in teaching the fundamentals of his science, and that he should delegate to his junior associates the conduction of advanced classes. This does not mean that he himself should not offer some advanced course in a subject in which he is specially interested and proficient, but it does mean that to leave to immature and undeveloped assistants the teaching of the fundamentals of the subject as a whole is pedagogically unsound, and is certain to produce a class of students that are unequally trained, and, besides, have a low estimate of the value of the course.

The object of a course in physiology being to train the student in the exercise of his faculties, rather than to jam his memory full of the accumulated truths that fill its

archives, it is important that he begin under the instruction of one who by experience is able to present the sequence of evidence which leads up to the establishment of even the most elementary truths of his science. If the scientific attitude be acquired at the beginning, the student's mind is prepared for the constant acquisition of new knowledge, which he comes to be able to assimilate with less effort, and with immensely greater profit to himself.

An unfortunate feature of every course is the necessity of examination. The necessity exists for two reasons: 1. To offer a disciplinary method by which each student is compelled to study the subject. 2. To ascertain whether he has mastered his subject sufficiently. It is not the purpose in the present paper to enter in any detail into this much-discussed pedagogical problem. It is certain, however, that in no other respect is the teaching of such a subject as physiology likely to be rendered inefficient and unpractical more than by too much examination. As we have stated before, a record of the general behavior of each student in the quizzes, in the practical courses, and in the symposia, should be kept, so as to serve as the main basis upon which his proficiency is determined, the finer grading being based on a comprehensive final examination, which should be partly oral and partly written in nature. In this final examination opportunity would be offered to sort out those students whose standing, as judged from the class records, is uncertain.

Occasional written "tests" are no doubt of some use in permitting the students to measure their standing, and in supplying them with a motive for reviewing their work. But it is a mistake to offer these tests too frequently, for it makes the student consider the obtaining of high grades as the main aim and object of his studies. By his success in getting high grades, the crammer, who merely memorizes what he hears or reads, comes to be considered as the really successful student, whereas the thinker who accepts nothing until he understands it is discouraged because he can not keep the pace.

And finally as to the future of the physiological student, how is his fund of knowledge to help him most in becoming an efficient diagnostician and therapeutist? The answer is by keeping him in constant touch with physiology during the time that he is acquiring his clinical knowledge. To accomplish this is, however, a most difficult problem, for it requires that the teacher of clinical medicine shall himself be well informed in the modern teachings of physiology, a qualification which unfortunately but few of our clinical experts possess, or which they make any effort to acquire. There has no doubt been a great change in the nature of the teaching of clinical medicine during recent years. The old-fashioned empirical dogmatism is gradually giving way to more logical and scientific methods, but even in our best-manned school clinics, there yet remain many who by their attitude towards such a science as physiology and towards the newer methods of refined diagnosis, which depend on the application in bedside work of physiological methods, make it very difficult to realize the above ideal. Naturally enough the unthinking student prefers to be taught cut-and-dry systems of diagnosis and treatment. In his textbooks of medicine, he finds tabulated groupings of symptoms by which he may distinguish one disease from another, and he expects that, having learned how to diagnose, all he has to do is to learn the prescribed treatment for the disease. By learning his medicine in such a manner—and of course it is in such a way that he

learns it when he attends so-called quiz classes in medicine—he is very likely to lose all of his scientific attitude towards the management of disease. He comes to think of diagnosis as being nothing more than an endeavor to find the text-book name for the disease under which the grouping of symptoms which he elicits happens to fall, and he loses sight of the fact that the symptoms are the outcome of disturbed function or functions, and that they may vary very much indeed in different individuals, according to the degree of physiological disturbance which the lesion creates. He becomes a student of symptoms rather than an investigator of the conditions which are their cause. After all, text-books of medicine are intended only as rough guides for the classification of disease, and it is fatal to efficiency in medical training if this fact is not constantly borne home on the student. He must be taught to study and treat each patient as an individual problem, and just as he has learned in the practical course in physiology that the same experimental condition may lead to different reactions in different animals, so must he expect to find among different patients the same want of uniformity in the symptoms which are produced by the same lesion. The student must be constantly reminded that the practise of medicine is in its merest infancy, and that its growth depends almost entirely on the degree to which it will be possible to apply the accurate methods of physiology and experimental medicine to its investigation. In the past, the development of knowledge of the disease of the circulating system, for example, has depended upon the use of the simple methods of auscultation and percussion; at the present it is bound up with the use of the electrocardiogram, the polysphygmogram and the skiagram, and in the future it will undoubtedly be largely dependent upon methods which will be born and cradled in the physiological laboratories. Every man trained in the right atmosphere becomes a potential contributor to the advancement of clinical knowledge.

In order to carry out these ideals in the teaching of medicine, it is necessary to provide courses such as experimental pharmacology and so-called experimental medicine, in which the more purely physiological experiment is modified so as to show how its results can be used in the investigation of disease. By giving pharmacology in the third year of the medical course, and experimental medicine in the fourth, the difficulty that the student will disregard the scientific aspect of medical practise is much lessened.

In this discussion it should be pointed out that the term physiology is employed in the broad sense under which it was defined at the outset, that is: it includes the physical, the purely biological and the chemical phenomena of life.

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ACCIDENTS IN COAL MINES

THE lack of comparable and accurate statistics of coal-mine accidents in the United States has led the Bureau of Mines to collect such data, and the results of these investigations have been compiled by Mr. F. W. Horton, in Bulletin No. 69, entitled "Coal Mine Accidents in the United States and Foreign Countries," which has just been issued. This report shows that during 1912, 2,360 men were killed in the coal mines in the United States as compared with 2,719 for 1911, and that the fatality rate was lowered from 3.73 in 1911, to 3.15 per 1,000 men employed in 1912. The report contains statistical information concerning the production, the number of men employed and the number of men killed in each state since 1896. From 1896 to 1907 the number of men

killed per 1,000 employed gradually increased with only slight fluctuation; the number killed per 1,000,000 short tons also increased, but the rate fluctuated over a wider range.

During this twelve-year period through 1907, the increase in the death rate was accompanied by an enormous increase in the production of coal. In 1896 the output was 191,986,000 tons, and in 1907 it was 480,363,000 tons, an increase of over 150 per cent. In 1896 each man employed produced 2.64 tons coal per day, whereas in 1907 the daily production of each man was 3.06 tons, an increase of 16 per cent. Since 1907 there has been a marked decrease in the number of fatalities at the coal mines.

This general improvement has been brought about by a combination of causes, the principal one of which has been more efficient and effective mine inspection on the part of the state mining departments and the state mine inspectors throughout the country, supplemented by greater care on the part of both operators and the miners. The investigative and educational work of the Bureau of Mines has kept both the operator and the miner alive to the various dangers connected with coal mining, and has shown what precautions should be taken to avoid these dangers. As a result of these educational features, mining companies are organizing safety committees; providing emergency hospitals, training men in first aid and rescue work, so that in case of a disaster they are equipped to cope with any ordinary accident.

The fatality rates in a number of foreign countries covering a period of ten years, 1901 to 1910 inclusive, are as follows:

Great Britain, 1.36 per 1,000 men employed; Germany, 2.11; France, 1.69; Belgium, 1.02; Japan, 2.92; Austria, 1.04; India, 0.96; New South Wales, 1.74; Nova Scotia, 2.65, while the rate for the United States was 3.74. The low fatality rates in the foreign countries may be accounted for largely by reason of the fact that coal-mine inspection has been in operation much longer than in the United States. In Great Britain the coal mine accident statistics have been collected, published and studied since 1851; France, 1853; Austria, 1875; Germany, 1852; and Belgium, 1831.

A chronological list of the more disastrous coal-mine accidents in the United States shows that 275 accidents have occurred since 1839, in which five or more men were killed at one time, representing a total of 6,777 fatalities. Of these accidents there were 135 that killed from five to nine men each, a total of 859; eighty-two that killed from ten to twenty-four men each, a total of 1,237; twenty-five that killed from twenty-five to forty-nine men each, a total of 870; eighteen that killed from fifty to ninety-nine men each, a total of 1,221; eleven that killed from 100 to 199 men each, a total of 1,534; three that killed from 200 to 299 men each, a total of 695, and one that killed 361 men.

Of these larger disasters gas and coal-dust explosions caused 183 accidents and 5,111 deaths, or over three fourths of the total number of men killed. The next greatest number of deaths were from mine fires, which caused the loss of 1,082 lives, or over fifteen per cent. of the total number killed, by thirty-three separate accidents. It may thus be seen that accidents from gas and coal-dust explosions and mine fires account for more than ninety per cent. of the total number of men killed in these large accidents, although falls of roof, pillars and walls claim nearly fifty per cent. of the total fatalities.

THE RADIUM RESOURCES OF THE UNITED STATES

Secretary Lane proposes to withdraw all lands of the public domain suspected of containing radium, that their deposits may be secured for the public good and not become the subject of private speculation. Mr. Lane has outlined his plan in a letter to Chairman Foster of the House Mines Committee, urging immediate passage of a joint congressional resolution to empower President Wilson to make the withdrawals. Investigations of the Geological Survey have located public lands believed to contain the substance now so invaluable in medicine. By the terms of the proposed resolution the Secretary of the In-

terior would be authorized "to conduct explorations and researches with a view to determining the practicability of developing from such ores a supply of radium and to provide for the mining and treatment of radium-bearing ores in such manner as would best secure a supply of radium for the use of the government of the United States and the hospitals of this country."

Secretary Lane points out that there are only two grams of radium at present in the United States. It is valued at $120,000 a gram. All has been procured from Europe. "Three fourths of the radium produced in the world during the year 1912," says Secretary Lane, "came from American ores, yet we have, up to this time, taken no steps whatever to preserve for our own people this invaluable metal, and our physicians and hospitals are dependent upon European laboratories for such supply as they can procure, and are subject to whatever monopoly charge the European laboratories demand for their product."

In view of the use of radium in the treatment of cancer and the difficulty now experienced in obtaining a supply of it, Secretary Lane says, that as one person in every ten in this country more than fifty years of age suffers from cancer, "it is difficult to overestimate the necessity of securing immediately as large a supply as possible of this mysterious remedy." Continuing, the secretary says: "Radium is found in ores carrying uranium and vanadium, which are used extensively in the arts, and processes by which it is extracted are secret. A process has been invented by the chemists in our Bureau of Mines which promises, from the laboratory experiments thus far made, to be successful. Under the endowment of two Americans, a building is now being erected in Denver (which, with its equipment, will be opened for work in the coming February), in which an effort will be made to prove the commercial possibility of this American process. If successful, this process will be given to the world, and all of the radium secured over and above a small minimum will be the property of the United States, and will be put into the hands of the United States Public Health Service for public use. Under all these circumstances it seems to me that the only prudent course that the United States can follow is to withdraw such of its lands as are supposed to contain radium from public entry. This will guard against those lands being taken up by those who would not put them to their highest and most beneficial use. It would be inhuman to deprive other nations of access to our radium deposits if they alone were masters of the secret by which this mineral could be secured, and it is believed that there is a sufficient amount of carnotite and pitchblend already in private ownership in this country to permit of continued European experimentation and production. The people of the United States, however, should be entitled to protection against the exhaustion of this resource and its exclusive control by the scientists of other lands."

SCIENTIFIC NOTES AND NEWS

IT is proposed to place a suitable memorial of the late Alfred Russel Wallace in Westminster Abbey. It is also proposed to present a statue or bust to the British Museum of Natural History and a portrait to the Royal Society. Contributions to the Alfred Russel Wallace Memorial Fund may be sent to the Union of London and Smith Bank, Holborn Circus, London, E. C.

LORD RAYLEIGH will unveil a tablet to the memory of Lord Lister at King's College, London, on January 14. The ceremony will be followed by the inaugural lecture of the newly appointed professor of physics, Professor O. W. Richardson, F.R.S., recently of Princeton University, who will take as his subject "The Discharge of Electricity from Hot Bodies." Lord Rayleigh will also preside at this lecture.

SIR ARCHIBALD GEIKIE, the distinguished British geologist, has been appointed a member of the Order of Merit, filling the vacancy caused by the death of Alfred Russel Wallace.

OTHER New Year's honors in Great Britain include a viscountcy conferred on Mr. James

Bryce, recently British ambassador at Washington.

The National Geographical Society has awarded a medal in honor of the late Professor Franklin Hiram King for his work on Chinese agriculture.

Colonel Gorgas, M.D., chief sanitary officer of the Panama Canal, has been elected an honorary fellow of the Royal Sanitary Institute, London.

The executive committee of the board of trustees of Cornell University has made the following expression of its feeling with respect to the resignation of Professor J. H. Comstock:

> In accepting the foregoing resignation the trustees congratulate Professor Comstock on his long, honorable and fruitful service to Cornell University, with which as student and teacher he has been associated almost without interruption since he matriculated as a freshman, and they bear grateful testimony to his success in teaching and in inspiring students and also in scientific investigation, for the continuance of which they trust his health and energy may be preserved for many years to come to the honor of his alma mater and the advancement of truth and knowledge.

After accepting the resignation of Professor Charles DeGarmo, the committee adopted the following minute:

> Dr. DeGarmo came to Cornell after twenty-five years' labor as teacher and administrator in school, college and university. Under his guidance the department of education was reorganized and has been a large factor in the preparation of many students for usefulness. During his years of service to Cornell he has wielded a widespread influence in the country through his writings, his addresses to gatherings of school men, his helpfulness to those charged with school administration. In the university he has inspired others by his teaching and even more by the gentle nobility of his character, and by his steadfast devotion to the highest standards of life and work.

Professor Simonin, of the Paris Observatory, Professor Abraham, of the University of Paris, and Captain Carrier, of the French army, the three savants cooperating with a similar party of Americans in determining, with the assistance of radio signals, the difference of longitude between Washington and Paris, recently delivered short addresses before an audience comprising the Naval Observatory staff and representatives drawn from the naval and scientific circles of Washington.

At the annual meeting of the American Ornithologists' Union in November last it was decided to increase the membership of the Committee on Classification and Nomenclature from seven to eleven with the object of having it organize as two subcommittees, one of four members to consider matters of nomenclature, the other of seven members, to cover systematic and geographic questions, especially the acceptance or rejection of proposed new forms. The president, Dr. Frank M. Chapman, has reappointed the old committee, consisting of J. A. Allen, William Brewster, Jonathan Dwight, Jr., C. Hart Merriam, Charles W. Richmond, Robert Ridgway and Witmer Stone; and as the four additional members he has named Joseph Grinnell, E. W. Nelson, Harry C. Oberholser and T. S. Palmer.

Mr. G. W. Lamplugh, F.R.S., has been promoted to be assistant director of the Geological Survey of Great Britain, and Mr. T. C. Cantrill to be district geologist.

W. S. Valiant, for twenty years assistant in the geological museum of Rutgers College, has been appointed curator. Professor J. Volney Lewis, formerly designated curator, has been made director.

The autumn series of public lectures, given at Washington University, St. Louis, came to a close with an address by Dr. Eugene L. Opie on "Modern Tendencies in Medicine."

The Friday evening meetings of the Royal Institution, London, will be resumed on January 23, when Sir James Dewar will speak on the coming of age of the vacuum flask. Among the lectures announced is one on the mechanics of muscular effort, by Mr. H. S. Hele-Shaw, F.R.S., and another on the production of neon and helium by electric discharge, by Professor Norman Collie, F.R.S. On February 20 Professor Arthur Keith, conservator of the Museum of the Royal College of Surgeons of England, will relate the results of an

anthropological study of the busts and portraits of Shakespeare and Burns.

THE library of the late Professor Ernest Ziegler, formerly professor of pathology at the University of Freiburg, purchased for the University of Pittsburgh by Mr. Richard Beatty Mellen was formally presented to the university at a meeting held in the University Club, Pittsburgh, December 5. The addresses of the evening were given by Dr. William H. Welch, Baltimore, and Mr. Harrison W. Carver, Pittsburgh.

DR. S. WEIR MITCHELL, distinguished as a man of science, as a man of letters and as a physician, died at his home in Philadelphia, on January 7, at the age of nearly eighty-four years.

DR. SETH CARLO CHANDLER, the distinguished astronomer, at one time assistant to Dr. B. A. Gould, aid in the U. S. Coast Survey and in the Harvard College Observatory, since 1885 engaged in private investigation, died on January 31, at the age of sixty-seven years.

DR. FREDERICK CARL BUSCH, for some years professor of physiology at the University of Buffalo, recently engaged in cancer research, died from that disease on January 3, aged forty years.

HIRAM JOHN MESSENGER, Ph.D. (Cornell), for the last fifteen years the actuary of the Travelers Insurance Company, at one time associate professor of mathematics in New York University, author of publications on social statistics, died at his home in Hartford, Conn., on December 15.

BY the will of the late Mr. Arnold Friedlander, an English merchant, $25,000 is left for a cancer research fund.

THE Ecuadorean government has approved the contract with a London firm for the sanitation of Guayaquil. The question of cleaning up Guayaquil has been under consideration for a long time. Bubonic plague and yellow fever have been prevalent there, and the proper sanitation of the port was made the subject of an investigation by Colonel William C. Gorgas, head of the sanitary work in the Panama Canal zone. The installation of a proper sanitary system has been made imperative by the early opening of the Panama Canal. It is understood that the cost of the work will approximate $10,000,000.

UNIVERSITY AND EDUCATIONAL NEWS

THE movement for the establishment of a national university in Washington on the plan indorsed by the National Association of State Universities is taking form, and President James, of the University of Illinois, has, it is understood, commenced the preparation of a bill soon to be submitted to President Wilson for his approval and afterwards to be introduced in both houses of Congress. The bill will carry a preliminary appropriation of $500,000 toward the establishment of a university to be under the control of a board appointed by the president of the United States. It will propose an advisory board made up of one delegate from each state to frame the policy of the institution.

THE will of the late Seth K. Sweetser, of Brookline, Mass., makes public bequests amounting to $137,000, including $25,000 to the Massachusetts Institute of Technology.

ANNOUNCEMENT is made that the Cleveland City Hospital and the school of medicine of Western Reserve University are to be affiliated. The agreement which will be entered into by the city and the university will provide that all members of the visiting staff of the City Hospital shall be nominated by the trustees of Western Reserve University upon recommendation by the faculty of the school of medicine. The visiting staff will have absolute authority over the professional treatment of all patients of the hospital. The director of public welfare will be the administrative head of the hospital. The university will have all teaching and research privileges.

TWELVE colleges, hospitals and charitable institutions of Minnesota, nine of them in Minneapolis, are the recipients of New Year's gifts aggregating $230,000 from David D. Stewart, of St. Albans, Me., who inherited the

estate of the late Levi M. Stewart, of Minneapolis. Mr. Stewart in the last year has given away $630,000, practically half of the estate that was left him. About $400,000 went to churches, colleges and charitable institutions in Maine.

By the action of a New Haven court Yale University is adjudged not entitled to a legacy of $700,000. The money was devised by Mrs. Henry O. Hotchkiss, who died last year. The court rules that the will is void because Mrs. Hotchkiss did not get for herself complete and ultimate control of the money.

Dr. John Huston Finley was installed president of the University of the State of New York and commissioner of education on January 2. The inaugural address by Dr. Finley was given in the afternoon session. Other speakers included St. Clair McKelway, chancellor of the university; Nicholas Murray Butler, president of Columbia University, and Calvin N. Kendall, commissioner of education of New Jersey. The program for the evening included addresses by Governor Glynn, Franklin K. Lane, secretary of the interior; Charles W. Eliot, president emeritus of Harvard University, and Jean J. Jusserand, ambassador from France.

The American Political Science Association at its Washington meeting last week adopted a resolution providing for the appointment of a committee of three "to examine and report upon the present situation in American educational institutions as to liberty of thought, freedom of speech and security of tenure for teachers of political science." The committee was authorized to cooperate with similar bodies of other societies of the social sciences.

The examiners for the Shaw Fellowship open to graduates in philosophy of the four Scottish universities have recommended that it be awarded to Mr. G. A. Johnston, of Glasgow. It is of the annual value of about £160, and is tenable for five years.

Mr. A. E. Mortimer-Woolf has been appointed demonstrator in the department of anatomy at King's College, London.

Mr. George Senter, D.Sc. (Lond.), Ph.D. (Leipzig), reader in chemistry in the University of London and lecturer in chemistry at St. Mary's Medical School, has been appointed head of the department of chemistry at Birkbeck College, London, in succession to Dr. Alexander McKenzie, who has been elected to the chair of chemistry at University College, Dundee (University of St. Andrews).

DISCUSSION AND CORRESPONDENCE

A MODERN TEXT-BOOK OF GEOLOGY—AND EVOLUTION

Time, after all, is a matter of relativity for most of us. To-day, under circumstances, may really be yesterday. A little scientific book of the time of the middle of last century—a few years, say, after the publication of Darwin's "Origin"—has just come under my eyes. But it could not have come much before because its title page bears the imprint, "Quebec, 1913."

It is a little text-book (in French) of geology: "Abrégé de Géologie, par L'Abbe V.-A. Huard, A.M., Directeur du Naturaliste Canadien, Conservateur du Musée de l'Instruction Publique, et Entomologiste officiel de la Province de Quebec."

It is one of a series of similar books by the same author (zoology, botany, mineralogy, geology) which form a "Cours abrégé d'histoire naturelle, à l'usage des maisons d'education." It is, in other words, an introduction and guide to science for the rising generation of French Canadians.

It comprises six chapters about the earth's crust, the agents that modify it and the fossils that lie in it; and a seventh divided into two articles: "Art. 1, L'histoire primitive du genre humain; Art. 2, Ce quil faut penser du transformisme." It is this last chapter particularly that seizes one's attention.

The first paragraph of the first article concerns the "age of the human species." It is as follows:

"The infallible authority of the Church—[have I neglected to mention that the reverse

of the title-page of this text-book for secondary schools bears the imprint, "*Nihil obstat*," followed by the signature of the "*censor designatus*" and the *imprimatur* of the bishop administrator of Quebec?]—the infallible authority of the Church has made no definite determination as to the date when God created man, nor, by consequence, when man commenced to exist upon earth. There is a chronology in the Holy Books written under the inspiration of God, but in addition to the fact that it must be admitted that in the work of the ancient copyists extending over long periods of time the figures of this Biblical chronology may have been considerably altered, we may believe also that the sacred writer has not pretended to any completeness of genealogy of the patriarchs. Thus from the evidence of Revelation there is no absolute statement to be made relative to the existence of man on the earth; moreover, this is a question that interests neither dogma nor morals."

In two succeeding paragraphs the teacher states that geological evidence shows that man did not exist in the Tertiary epoch. The geological indications are that the creation of man dates from the end of the first period of the Quaternary. "One may add that there is to-day a tendency to believe that the human species has existed for 9,000 or 10,000 years; but this is only an opinion more or less probable that each is free to accept or reject for himself."

The second part of the chapter takes up, as I have already indicated, the subject of evolution. It begins with a recognition and demonstration of the unusually favorable condition of the infants of Quebec as regards science.

"With us," writes the good Abbe, "the little child when it has well learned its catechism is sure of the solution of the most grave problems which can disturb the human mind; it is in possession of the truth on the most important of questions. It knows, for example, the existence of God, that is to say the existence of the eternal Being whose perfectness and power are infinite. It knows that God has created, that is to say produced by an act of His will, the whole visible and invisible universe; and as regards our earth, it knows that God has created all the kinds, mineral, vegetable and animal that are found on it. The science of this little child is then already immense, and it is certain."

In painful contrast to this, the teacher finds that "in other lands there are unfortunately men who pass for savants, who ignore or refuse to admit and even combat these truths which rest not alone upon revealed religion, but also upon philosophy and upon the natural sciences where they are impartially questioned and legitimately understood. These men attribute all the development of the world, organic and inorganic, solely to the forces of nature, and they do this either to eliminate any necessity of intervention in this development by God or to discredit the Church which He has established." However, our author admits in a footnote[1] that not all evolutionists have such perfidious intentions, these others being engaged in following the chorus-masters of evolution simply by their lack of scientific knowledge and capacity for reflection, or because they wish to be believed to be in the scientific swim, *à la mode*.

M. Huard then proceeds to a brief setting forth of the actual hypothesis—the absurd hypothesis- of transformism, and of the trivial and thoroughly exploded alleged factors of this evolution: namely, natural selection, the influence of the use of organs, and the influence of the environment. "It is necessary to add that these famous principles of the evolutional hypothesis have no longer many partisans to-day, because the actual facts have proved their unreality. It is well, however, to know them at least by name, because of the historic interest which still attaches to them."

M. Huard then offers a series of scientific criticisms of evolution which are sufficient in themselves to make untenable any belief in it, without making appeal at all to those other

1 "Il ne manque pas, assurément, d'évolutionnistes qui n'ont pas ces intentions perfides, et qui ne se sont engagés à la suite des coryphées du transformisme que par défaut de science ou de réflexion, ou pour suivre ce qu'ils croient être le courant scientifique du jour."

presumably even more convincing "*motifs très graves*" that the theologians and philosophers have for disproving the hypothesis of the evolutionists.

These objections to evolution, "drawn exclusively from the domain of science," are as follows (quoted unabridged and unmutilated):

"1. The great objection that can be made, *a priori*, to evolution, and one which should make unnecessary all discussion, is that it is impossible to cite in its favor a single fact, well determined and legitimately interpreted, which shows that a single species has certainly evolved into another species. It is evident that a single fact of this kind would be sufficient, if not to establish solidly the hypothesis of evolution, at least to break much of the force and worth of the arguments of the adversaries of the hypothesis.

"2. As regards man himself, one has gone so far as to attribute to him for ancestor, the monkey, which by successive betterments should have finally become the human creature. Only, one can give no proof of this transformation; one knows none of the intermediate beings which should have formed an uninterrupted series between the monkey and man. Let us add that whether we consider the cranial development, or the anatomical structure, there are very great differences between man and even the most perfectly constituted monkey. It is the intellectual faculties, above all, which offer no ground of comparison between man and monkeys. It is necessary then to admit, from the scientific point of view, the direct creation of man by God.

"3. Just as the human being has remained the same from the beginning, so also have the animal and plant kinds remained the same, as proved by the study of fossils of all the geological epochs. There is not the least proof that a single species can, in however long a time, become another species. There have been, without doubt, both with man and with animals and plants, changes due to climate, nutrition, the soil, etc.; these changes have given rise to *varieties* more or less stable, within the species, but never to new species. The trilobites, for example, whose history can be followed in the geological strata up to their very end, since they did not persist beyond the Tertiary epoch, have offered in only a dozen of their three or four hundred species, no more than slight variations, which were not even completely maintained by their descendants.

"Evolution, *understood in a very restricted sense*, can then show us new varieties that only culture or other causes can produce; but there its power ceases, as experiment has demonstrated.

"4. Paleontology testifies that species have not appeared, from the beginning, as a series of successive, ever better stages, but they have appeared suddenly and without relation to the species existing before. And they have appeared all at once in all their relative perfection.

"5. If evolution had, as it is claimed, produced the perfecting of species, the last come among organisms would be the most perfect. Now, the study of fossils proves that the contrary is often true. For example, the most ancient fishes, the first sea-urchins, the oldest plants, the Carboniferous amphibia, were more perfect than the fishes, sea-urchins, amphibia and plants of to-day.

"6. It is not superfluous to add to what has preceded that since the beginning of historic time there has been recorded no sign of the passing of one species into another, neither among the plants nor animals.

"The conclusions to draw from all this are: (1) that the fixity of species is a scientific truth clearly and solidly established; (2) that God himself, author of all that exists outside of himself, has directly created man and all the animal and plant species."

To add anything to this is to produce the anti-climax. Yet it must be noted that Abbe Huard's text-book has not gone wholly without criticism in French Canada. In *Le Pays*, of Montreal, a writer took some exception to the Abbe's position on evolution. *Le Pays* was reprimanded by the Archbishops of Montreal and Quebec and the reading of the journal interdicted. In *Le Naturaliste Canadien* (October, 1913) (his own paper) the Abbe Huard refers appreciatively to the incident, and mentions

that the single one of the pro-transformism arguments of the writer in *Le Pays* which remains in his memory is, that the best geologists of the United States believe in evolution. The Abbe justly remarks that the argument does not seem to him overwhelming. For, he adds, they and even most geologists of the English language and protestant faith are partisans of evolution because of their lack of philosophic and religious instruction.

V. L. K.

STANFORD UNIVERSITY, CAL.

A SIMPLE APPARATUS FOR ILLUSTRATING PHOTOSYNTHESIS

THE use of experiments, illustrating the various physiological processes in plants, are coming more and more into use in connection with the teaching of elementary botany in the secondary schools. Unfortunately the funds available for the purchase of apparatus are so limited in many of these schools that the teacher has to resort to the method of making the various experiments before the class, while the students make notes on the results, etc., to be written up in their laboratory notebooks later. Such a method as this is very good if nothing better is available, but of course the best results are obtained by the students themselves making as many of the experiments as possible. I devised the following simple apparatus for illustrating the necessity of carbon dioxide and light in photosynthesis. Since it has worked with success, I thought that a short account of it might be justified.

Ordinary bottle corks, about 2 cm. in diameter, and 1 cm. thick, should each have a hole cut through the flat side with a large cork borer. The holes should be about 1.5 cm. in diameter. Through one side of each of the cork rings thus formed, a small hole should be made for ventilating purposes. The large hole in each ring should now be covered on one side by cementing on a small piece of mica, or, if mica is not available, small round cover glasses will do, but will require more careful handling subsequently as the glass breaks more easily than the mica. A sufficient number of these discs should be made to provide each student with six of them, two of which should be blackened to exclude the light.

In order to perform the experiment successfully a bright day should be selected, and only such plants should be used as have the stomata on the lower sides of the leaves. Plants with the stomata on both surfaces can be used, however, provided that the upper surfaces of the leaves used in the experiment are greased with cocoa butter or vaseline. The plant should be left in the dark long enough for the starch to be removed from the leaves before the experiment is started.

The cork discs, which have just been described, should be pinned to the leaves in pairs, one on the upper surface, and another on the lower surface opposite it so as to form small enclosed chambers in each instance. The blackened discs should constitute one pair so as to form a dark chamber. In order to exclude carbon dioxide the lower chamber of one of the other pairs of discs should contain small lumps of soda-lime, while the third pair will serve as a control to show that the presence of the discs themselves does not interfere with starch formation.

After the plant has stood in the sunlight for a few hours the leaves upon which the experiment is made should be removed, boiled in water, left in alcohol for a time and tested for starch in the usual way. If the experiment has been properly conducted, no starch will be present where carbon dioxide and light have been excluded, but it will be present in abundance under the discs used as a control. Groups of from two to four students can work together if the class is large and the number of discs limited.

It has been found that rather large-leaved plants with stiff petioles are better for use, in which case one leaf is sufficient for the three sets of discs. If plants with delicate leaves are used the discs can be supported by bending short lengths of soft iron wire at right angles near one end of each, and inserting the bent end in the side of one of the discs in each pair, while the other end of the wire is stuck into the soil below.

ALBAN STEWART

UNIVERSITY OF WISCONSIN

EXPEDITION TO THE AMAZON

To the Editor of Science: Mr. Algot Lange, of New York, writes from the headwaters of the Cairary and Mojŭ in the Amazon region, Brazil, as follows:

I took my 6-man canoe above 5 long and dangerous rapids at the headwaters of the Mojŭ and Cairary rivers and after 15 days search I got in touch with this virgin tribe. I use the term virgin because, as I sit here alone (the only non-savage man) among about 50 Indians, I see how absolutely untouched and unspoiled this tribe is. They use stone axes and I am now showing them the use of steel axes.

Their language is not Tupi. What stock can it be, Arowak or Carib? They are agriculturists and have felled about 30 acres of jungle, with their stone axes—it looks to me as if they must have chewed the trunks. They grow cotton.

The men go nude absolutely. The women wear a narrow, colored loin-cloth.

I am received very hospitably. I am here in commission by the government [of Brazil] to look up the indigenous tribes and ascertain their different social and economic possibilities and their most urgent needs and the best way of entering into friendly relationship.

Some of the men have almost Hebraic features with brown eyes. They are tall and muscular in build. They have great skill with the bow and arrow, one bow for tapir and jaguar hunting being eight feet long.

F. S. Dellenbaugh,
Secretary, Explorers Club

November 5, 1913

QUOTATIONS

FREE SPEECH AND THE FACULTY

If there is one place that freedom of thought and speech should be safeguarded, it is in our college and university faculties. Presumably, no professor is obliged to wear the gag, yet it is worth observing that members of the Political Science Association have seen fit to appoint a committee "To examine and report upon the present situation in American institutions as to liberty of thought, freedom of speech and security of tenure for teachers of political science." It may be that this measure is preventive rather than remedial. It may be that these instructors in political sciences apprehend pressure by means of the various endowment, retirement and pensioning funds and take this method of safeguard against a possible dilemma arising therefrom. But it is even more probable that the unpleasant experiences of certain of their number who have come into collision, by one means or another, with sectarian prejudices, sinister interference or powerful political rings have not been without a prompting effect. With the exception of the state universities, most of our academic institutions are, of course, dependent on the liberality of private donors. It is well known that the terms of these gifts are often embarrassing—half a million to build a museum for the testator's collection of private hobbies, when the institution needs a dormitory or a library. The difficulty is that a donor who is placing an institution as deeply under obligation as may be represented by a gift of hundreds of thousands would need to be a very extraordinary and superior person not to conceive that some sort of deference was due his opinions in return. It speaks well for the grade of men who have thus far endowed our colleges that there has been comparatively little interference with the truths they teach, at least so far as the public has been informed —what private griefs they have we know not. But as lines of political cleavage grow more distinct, as they promise to do, it will become increasingly difficult to maintain this attitude of non-interference, and it may be that this action of the professors of political sciences will yet prove to have been well-timed.

The episode raises the whole question of intellectual liberty. Each age has thought it won, and each age has seen a new difficulty arise out of the vanquishing of the old. The universities, whatever their faults, have always been sanctuaries for independent minds. Unless they are so maintained, they will hardly be worth the name. The distinction between liberty and license in the citizen is recognized and enforced. The same principle underlies all academic independence.—*Boston Transcript.*

"FREEDOM" AND FEES

It will, perhaps, do no harm to speak a little plainly of some aspects of the inquiry just instituted by the American Political Science Association into "the present situation in American educational institutions as to liberty of thought, freedom of speech, and security of tenure for teachers of political science." . . . The one point in the definition of the field of inquiry made by the association that is open to doubt and to discussion is "the security of tenure for teachers of political science." Here is where the assumptions to which we have referred come in. The gist of the matter is in the question how far a teacher of political science or of any other subject is entitled to retain his place and his pay when his teaching is not satisfactory to the trustees who are responsible for the institution in which he is employed.

That question is in some degree begged by the coupling of security of tenure with freedom of speech, as if the right to the former went with the right to the latter and as if a man not only had an inalienable right to teach whatever he chose, but a right equally inalienable to be paid for teaching it. That theory seems to us to need only to be stated to be rejected. It appears to us too clear to require discussion that the trustees of any institution of education ought not and can not surrender absolutely all control over the teaching in that institution to the men or the women who at any given moment happen to hold places in it. Nor is the matter changed materially if the trustees agree to turn over the control of the teaching to the faculty or to certain members of it. . . . Possibly the committee of the Political Science Association, with due study and reflection, in cooperation with like bodies, may be able to present some general rules or principles that may be useful. In the mean time it does no harm to suggest at the outset that there is no necessary, or even close, connection between the right to freedom of speech and the claim to be paid for speaking out of the funds of an institution the managers of which regard the speaking as mischievous.—*New York Times.*

SCIENTIFIC BOOKS

Lebensgewohnheiten und Instinkte der Insekten bis zum Erwachen der sozialen Instinkte, **geschildert von O. M. REUTER. Vom Verfasser revidierte Uebersetzung nach dem schwedischen Manuskript besorgt von A. und M. Buch. R. Friedländer und Sohn, Berlin, 1913. Pp. xvi + 448; 84 text-figures.**

This is the first of three volumes which Dr. O. M. Reuter planned to publish on the habits and instincts of insects. It treats only of the solitary species; the other volumes were to be devoted to the Socialia and to a general account of the sense-organs and the comparative psychology of insects. Most regrettably death has intervened to prevent the author from carrying out his plan and we are left with a single volume, which, however, is complete in itself.

The general account of insect behavior with which the work opens follows conventional lines. The activities are regarded as largely "instinctive," though the author is careful to state that some of them may properly be called "intelligent." Owing to the close association of instincts and bodily organization, he speaks of a "morphology of instincts and habits" and throughout the work views them from the evolutionary, or genetic standpoint. They are classified on a teleological basis, however, according to the problems which the insects have to solve in their daily lives. After an introductory chapter on the active and quiescent stages and the length of life of insects, the habits are arranged rather roughly under three heads, according as they subserve the purposes of nutrition, protection or reproduction.

The consideration of food-habits, though comprehensive, presents little that is new, the species being divided into omnivorous (Pantophaga), herbivorous (Phytophaga) and carnivorous (Sarcophaga). The two latter groups are each subdivided into Monophaga and Polyphaga, according as the insects derive their food from a single plant or animal or from several species. Two other groups of insects, the Necrophaga and Coprophaga, which feed on corpses and excrement, respectively, are also recognized. Parasitism is included under

the nutritive instincts, a conception which necessarily leads to a rather narrow and distorted treatment of this multiform phenomenon. The insects that feed on other animals are divided into three groups: typical prædators (Raptoria) parasitoid prædators (Parasitoidea) and true parasites (Parasita). The parasitoids include such forms as the so-called "parasitic" Hymenoptera, namely, the chalcis-flies, ichneumons, etc., which in their larval stage feed on the eggs, larvæ or pupæ of other insects, but as adults do not depart in structure from the non-parasitic members of their order, whereas the Parasita live even as adults on the bodies of certain hosts and also in this stage exhibit modifications of structure which adapt them to their peculiar life. At first sight this classification seems to be very satisfactory, but it breaks down on closer examination. If it were adopted one would have to classify the male Strepsiptera as parasitoids and their females as parasites. Moreover, Reuter's conception of parasitism is too narrow, because it includes only food parasitism and excludes phoresy (which Reuter, for some unknown reason, writes "Foresie") and brood parasitism. Reuter is, in fact, compelled to expand and modify his conception of parasitism as soon as he comes to consider the parasitic wasps and bees.

Commensalism, and more especially mutualism, are also somewhat too narrowly restricted by their inclusion under the nutritive instincts. Various forms of the migratory instinct are likewise considered under this head, as are also the various methods adopted by insects in protecting themselves from competing consumers. This latter subject forms a transition to the protective instincts proper. It is interesting to note that Reuter treats the toilet instincts ("Reinlichkeitsinstinkte") as protectives, since they have a sanitary value, no less than the methods of protecting the organism against excessive cold, heat, moisture, etc. Protection against enemies is distinguished as passive and active, the former comprising the cryptobiotic instincts (in the sense of Willey), protective coloration, mimicry, etc., the wonderfully diverse methods of forming the larval and pupal cases, autotomy and "death-feigning," while the actively protective behavior includes the use of the repugnatorial glands, the peculiar phenomena of "autohæmorrhœa," or emission of poisonous blood (often charged with cantharidin) from the joints of the legs in various larval and adult beetles, and phosphorescence, although this is in some cases passive (larval fire-flies) or connected with courtship (adult fire-flies). Reuter's treatment of the much-discussed subjects of protective resemblance and mimicry is very conservative. Any consideration of the many doubts which have been cast on these subjects by recent authors, especially in continental Europe, is omitted, as we should expect from the author's assumption that protective colors and devices are essentially passive, instead of being the stable results of once active adaptations.

Reuter devotes to what he calls the "instincts of metamorphosis" a chapter including the peculiar larval activities which leave the pupa in situations best adapted to the eclosion of the adult insect. This chapter clearly shows how impossible it is to draw a hard and fast line between the general physiological and morphological processes, on the one hand, and the instinct activities, on the other.

The reproductive instincts include the phenomena of courtship, that is, the exhibition by one sex of its peculiar movements, colors and structures, photogenesis, the use of the osmateria, or scent-glands, and such extraordinary pieces of behavior as that of the balloon-making male Empidid flies described by Girschner, Mik, Aldrich, Hamm and others, and finally oviposition and the extension of maternal and in rare cases also of paternal care to the eggs and larvæ.

The discussion of these and the foregoing subjects occupies about two thirds of the volume; the remainder is devoted to an excellent summary of the habits of the solitary wasps and solitary bees, and closes with two chapters on the adumbrations of social life noticeable in some non-social insects. The peculiar mixed arrangement of the materials relating to the wasps and bees is evidently intended to call attention to the parallelism or convergence in the phylogeny of their habits,

but it might have been better to have completed the account of each of these groups by itself and to have added a short chapter on the similarities due to convergence.

This very summary description of the contents of Reuter's work unfortunately fails to give any adequate conception of the large amount of very interesting and valuable reading it contains. As the first work to give a comprehensive survey of the habits of the solitary insects it is eminently successful. The writer has collated the essential facts from a very wide perusal of both the older and most recent literature on insect ethology, and has presented the matter in a very succinct and attractive style.

The volume ends with a well-selected bibliography of 60 pages and a good index. The bibliography includes many recent works on the social insects not cited in the text. There are few erroneous statements of fact like the one on p. 365, where it is said that ants appeared "in grossen Massen" in the Jurassic, immediately following the correct statement that "the existence of social Hymenoptera can not be demonstrated till Tertiary times." In the same paragraph we find the erroneous statement that termites occur in the Carboniferous.

The cuts in the text are mostly old, unattractive and poorly printed. Some of them set one to wondering why there are no good figures of many of our common insects, and why our author should be compelled to use, *e. g.*, the time-worn figure on p. 32 of the *Cicindela* larva, which is so small compared with its burrow that it could not possibly use its legs and dorsal horn in the manner described in the text. The number of typographical errors is considerable and many of them have not been corrected in the two pages of errata at the end of the volume. If it be true, however, as the reviewer is informed, that Reuter was blind for several years before his death, all of these errors and the poor selection of figures may be readily explained and pardoned.

W. M. WHEELER

Mind and Health, with an Examination of some Systems of Divine Healing. By EDWARD E. WEAVER, with an Introduction by G. STANLEY HALL. New York, The Macmillan Company. 1913. Pp. xv + 500. Price, $2.00 net.

The occasion for this book is the recent interest of some of the clergy in the practise of psychotherapy. After some account of the history, scientific basis and technique of psychotherapy, and a critical discussion of the merits of Christian Science, divine healing, "new thought," the Emmanuel movement, etc., the author reaches the conclusion that the church and its ministers can rightly and beneficially take a share in treating the sick. Religious faith and fervor, he urges, are a source of vitalizing energy which can be drawn upon for the maintenance and restoration of health. Character and health go together, and the minister of religion is, therefore, charged, to a degree, with the care of health. He should be acquainted with the scientific aspects of psychotherapy and should work in harmony with the physician.

R. S. WOODWORTH

Labrador. By WILFRID T. GRENFELL and others. New edition. New York, The Macmillan Co. 1913. $2.50 net.

The first edition of this standard work was recognized as a valuable addition to the literature on this practically unknown part of North America. The chapters on history, geology, Indians, birds, insects, mammals, etc., are admirable contributions from recognized experts.

While the new chapters by Dr. Grenfell have no scientific value, yet they are of popular interest, treating of animal life and of conservation. He sets forth pleasantly the lack of daring courage on the part of the bear and wolf, the domestication of the caribou, the food-value of the porcupine, the destructiveness of the lynx and the wiliness of the wolverine. On animal life he tells of the long winter experiences, when the bears sleep, the rabbits eat young birch, and the porcupine keeps to conifers. He adds: "Strangely enough none of the mammals rely on sight for protection. The difficulty of survival is in-

creased by constant warfare. The squirrel is never safe from the lynx, the caribou from the wolf, the rabbit from the fox."

As to conservation both sea and land game are steadily diminishing. The forests are fire-devastated, and immense waste continues in many directions. Indians and Eskimos are decreasing, and yearly bands escape starvation only through charity. Dr. Grenfell recognizes that the aboriginal inhabitants and the lower order of animals must go to the wall. He is however optimistic as to the development of Labrador; with the exploitation of the pulp forest for the whites, and by the reindeer herds for the natives.

The index completely ignores the new matter, an unfortunate oversight of the publishers.

A. W. Greely

BOTANICAL NOTES

THE FOURTH INTERNATIONAL BOTANICAL CONGRESS

Attention of botanists is called to the "first circular" in regard to the next International Botanical Congress, recently issued by the Organizing Committee.

Dear Sir and Colleague,

The International Botanical Congress, held at Brussels in May, 1910, decided, on the invitation of the Royal Society of London, that the next meeting of the congress, in 1915, should be held in London.

At a representative meeting of British botanists, held in London on May 10, 1911, a provisional bureau was nominated, consisting of three presidents (Professor F. O. Bower, Sir David Prain and Professor A. C. Seward) and a general secretary (Dr. A. B. Rendle). The bureau was empowered to cooperate with the permanent bureau of the Brussels Congress and to arrange for the appointment, in consultation with the British botanists, of an organizing committee. This organizing committee was elected at a general meeting of British botanists held in London on March 11, 1912; and at a second meeting held on May 17, an executive committee was appointed. A number of distinguished patrons of botany were also invited to lend their support to the congress.

The following general regulations for the conduct of the congress have been approved by the executive committee:

1. The Fourth International Botanical Congress shall be held in London from Saturday, May 22, to Saturday, May 29.

2. Membership of the congress shall be conditional upon subscribing to its regulations and the payment of a subscription of fifteen shillings. Members will receive all the publications of the congress. Ladies accompanying members may attend the meetings and excursions of the congress on payment of ten shillings each.

3. The work of the congress shall include the different branches of botanical science; and the congress will also carry on the work on (1) nomenclature, and (2) bibliography and documentation, left over from the previous meeting.

The permanent bureaus entrusted with the work concerned with (1) nomenclature, and (2) bibliography and documentation will act in conjunction with the executive committee.

4. Any language may be used in the discussions; if desired by the members, propositions shall be translated forthwith into English, French and German. English shall be the official language of the congress.

Particulars of meetings, discussions, excursions, etc., will be issued later.

American botanists are reminded that it is not too early to begin making arrangements for this congress. Communications may be addressed to the general secretary, Dr. A. B. Rendle, keeper of the department of botany, British Museum, Cromwell Road, London, England.

A NEW KIND OF BOTANICAL TEXT-BOOK

It is not often that the reviewer of books finds one of a new type, and especially is this true in regard to elementary text-books in science; yet in John G. Coulter's "Plant Life and Plant Uses" (Am. Book Co.) we find just such a case. It is so unlike the usual book designed for beginners in botany that the author allows the use of the word text-book only with particular limitations and restrictions. Avowedly intended as "a foundation for the study of agriculture" and "domestic science" the author has not al-

lowed this purpose to change materially the presentation of "the large essentials of plant life." "The effort is to include what has proper place in the education of *all* young people," and he distinctly excludes those special matters which are best relegated to agriculture, horticulture, domestic science, forestry, etc. In other words, we have here what the author believes all young people should know about plants as a general foundation for the subjects named, or even as a preparation for college botany. The present reviewer is in hearty accord with this educational theory, and he believes that in all well-considered schemes of education pure science must precede applied science.

The book is written in an easy, almost conversational style, and one wonders just how it is likely to be used by the ordinary teacher. It can scarcely be "recited" by the pupil, and possibly this may be a point in its favor. Perhaps this is why the author has added questions after the chapters, usually a feature of doubtful value, from the temptation it offers to the illy-prepared teacher to hold the book and ask the questions noted down before him.

Looking through the book, one is struck by a freshness of statement, showing that the author feels that he has a message for the high-school pupils of the country, and this continues with unabated enthusiasm from the first paragraph of the introduction to the closing paragraph of the book. It should do much to place high-school botany in this country upon a higher plane than it has ordinarily attained.

A NICE LITTLE DIATOM BOOK

One of the most attractive little books that we have seen in many a day is one entitled "Bacillariales" by H. v. Schönfeldt, and published by Gustav Fischer, of Jena. It is volume 10 of the series of booklets now in course of publication entitled "Die Süsswasserflora Deutschlands, Osterreichs un der Schweiz" and edited by Professor Doctor Pascher, of Prag. There are to be sixteen of these booklets, bound in limp cloth, each measuring about 11 × 19 cm. The book before us gives ten pages to structure, cell-contents, movements, reproduction, collecting, mounting and the literature of the group. Then follow 163 pages of systematic descriptions, the general treatment following that by Schütt in Engler and Prantl's "Natürlichen Pflanzenfamilien." Fourteen pages are given to the round diatoms (Centricæ), including eight genera and thirty-five species, while about 150 pages are given to the long diatoms (Pennatæ) in which are included about 40 genera and 390 species. These figures emphasize the statement often made that the round diatoms are mostly marine, and the long diatoms mostly inhabitants of fresh waters. Probably the truth is that in fresh waters we find many more long diatoms, because there are many more of them in the world at large, but this does not wholly account for the great disparity in numbers.

There are 379 cuts in the text, which must help the student greatly in his attempts to understand the structure and especially the markings of the cell-walls. A well-arranged index of scientific names closes this handy little book. One can not lay down this book without the wish that some day we may have something like it for this country.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

SUSCEPTIBILITY GRADIENTS IN ANIMALS

THE writer has called attention in several papers[1] to the existence of axial gradients in rate of metabolism in planarians and other forms and their significance in relation to polarity. During the past summer in the course of other work at Woods Hole the opportunity presented itself to examine various forms belonging to different groups and various embryonic and larval stages for the existence of such gradients.

The method used was that of determining the relative susceptibility of different regions

[1] *Jour. Exp. Zool.*, XII., 1912; *Arch. f. Entwickelungsmech.*, XXXV., 1913; XXXVII., 1913.

of the body to certain narcotics and poisons, KCN, alcohol and ether being chiefly used. To concentrations of these and various other substances which kill within a few hours without permitting any acclimatization the susceptibility varies in general with the rate of metabolism, or of certain fundamental metabolic processes, *i. e.*, the higher the rate of these processes the greater the susceptibility and the earlier death or cessation of movement occurs.[3] Death in these reagents is usually followed very soon, often almost at once, by rounding, separation or disintegration of the cells, so that the time of death can be approximately determined by visible changes of this kind. Results obtained in this manner can be controlled by removing the animals from the solution at different periods and determining when recovery ceases to occur and experience has shown that these two methods of procedure give essentially similar results. In this way the following forms were examined.

In *Nereis virens* the regional susceptibility of developmental stages from the beginning of cleavage to the late trochophore was determined. In the early cleavage stages the micromeres are more susceptible to KCN 0.005 *m.* than the macromeres. They not only disintegrate before the macromeres when the eggs remain in the solution, but if the eggs are returned to sea water at the proper time the micromeres alone are killed and the macromeres recover and resume division, giving rise to defective larvæ.

At the stage when gastrulation is nearly completed the somatic plate region is apparently the most susceptible region of the embryo, and by return to water at the proper time it is possible to obtain larvæ which do not elongate posteriorly and do not form the three larval segments. If the embryos at this stage are left for a longer time in KCN before return to water, both somatic plate and some or all of the macromeres are killed and the intact portion consists of more or less of the ventral portion of pretrochal and post-trochal ectoderm with or without a part of the macromeres. Evidently the most susceptible regions at this stage are first the somatic plate, and second, the dorsal part of the pretrochal region and the macromeres.

In the developing egg of another annelid, *Chætopterus pergamentaceus*, the relative susceptibilities of different regions are much the same. In the early stages the animal pole shows the highest susceptibility and in later stages a second region of high susceptibility appears in the somatic plate. In still another polychæte, *Arenicola cristata*, the apical region and somatic plate of the young trochophores are the most susceptible regions. The early cleavage stages of this species were not obtained.

In *Nereis* and *Chætopterus* the region about the animal pole is clearly the region of greatest susceptibility, *i. e.*, of greatest metabolic activity in the early stages of development. Later the activity in this region becomes relatively less in *Nereis* as differentiation of the apical larval region advances and the somatic plate becomes the most active region of the egg. But in *Chætopterus* the apical region retains its susceptibility to some extent at the completion of gastrulation, and this region and the somatic plate appear as distinct regions of high susceptibility. In other words, at the beginning of development an axial metabolic gradient exists with the region of highest rate about the animal pole, but as development proceeds this gradient is altered from its primary simple form by the increase in activity of the cells which give rise to body segments and later by decrease in activity in the animal pole region.

In the egg of the sea urchin *Arbacia* in KCN 0.005 *m.* a distinct susceptibility gradient was observed during cleavage, death and disintegration beginning at one region of the egg and proceeding along an axis, but it was not possible to determine whether the region of highest susceptibility was always the animal pole, though in many cases it certainly was. In the later gastrula and prepluteus stages this simple gradient was complicated by the appearance of high susceptibility in the re-

[3] Child, *Jour. Exp. Zool.*, XIV., 1913.

gions where the arms were beginning to develop.

Since in *Nereis*, *Chætopterus* and *Arbacia* the different susceptibilities of different regions of the developmental stages make it possible to kill with more or less exactness certain parts of the embryo while other parts may recover and continue development, this method may prove of some value in further investigation of the regulatory capacities of the less active regions when isolated from the influence of the more active.

The adult forms of a number of species from various groups were examined for a susceptibility gradient. In the hydroid *Pennaria tiarella* with KCN 0.0025 *m.* and 0.005 *m.* such a gradient appears very clearly in the body of the hydranth, death and disintegration beginning at the distal end of the manubrium and proceeding proximally. A similar gradient exists in the medusa buds of this species. Besides this it was observed that the full-grown hydranths at or near the tips of stem or branches were in general more susceptible than the more proximal. This difference may be due to external factors such as the lower oxygen or higher CO_2 content of the water about the more proximal hydranths in consequence of the greater number of hydranths in a given area, but it seems more probable, in the light of various data concerning the polarity of plants, that this difference in susceptibility of distal and proximal hydranths is the expression of an axial gradient in the colony.

In several other species of hydroids examined at Woods Hole and at La Jolla, California, among them *Tubularia crocea* and *Corymorpha palma* the gradient in the hydranth body is similar to that in *Pennaria*.

The ctenophore *Mnemiopsis leidyi* shows a distinct gradient in susceptibility along each row of swimming plates. The susceptibility of these animals to KCN is very high and most experiments were made with KCN 0.0000375 *m.*—00005 *m.* Rhythmic movement of the plates ceases first at the central end of each row, *i. e.*, the end nearest the apical sense organ, and last at the peripheral end. Before movement has entirely stopped in the apical region the rhythm of the plates in the peripheral half or third of the row becomes different from the central rhythm, being usually more rapid and in some cases irregular or periodic. In two cases a perfectly distinct reversal in direction of the impulse was observed at the peripheral end of a row after movement at the central end had ceased. In this case the impulse started at the extreme peripheral end of the row and traveled some distance in the central direction, finally dying out. This continued for an hour or more before movement at the peripheral end ceased.

This susceptibility gradient is undoubtedly a gradient in the nerve and not in the plates themselves, for the plates do not die in KCN until long after rhythmic movement ceases, and as long as they remain alive direct contact stimulation of single plates produces slight movements of the plate stimulated. However, a slight susceptibility gradient does exist in the plates themselves as is evident from the fact that the plates at the central end of the nerve die first and death proceeds peripherally. The time of death is readily determined, for when they die the plates lose their interference colors and become white and opaque.

As regards the general ectoderm of *Mnemiopsis*, it is difficult to determine the time of death accurately, but observations thus far indicate that the disintegration of the ectoderm proceeds from the apical region.

During the course of my observations on susceptibility gradients Dr. Tashiro called my attention to his discovery of a quantitative gradient in CO_2 production in the claw nerve of the large spider crab, *Libinia canaliculata:* this is a long nerve which readily separates into small strands and is therefore favorable for observation of any structural changes which might occur in connection with death in solutions of narcotics. The nerve is mixed but is believed to consist largely of efferent fibers.

Since there is some evidence in the work of various authors that a gradient of some sort exists in the nerve, the attempt was made to

determine whether a gradient would appear in the structural death changes. A number of nerves were observed in various concentrations of KCN from 0.001 *m.* to 0.01 *m.* In these solutions the fibrillæ become after a time irregular in outline and more or less varicose so that the strand appears more or less granular instead of fibrillar like the fresh living nerve. The preparations showed some indications of the progression of the change from the central to the peripheral end of the nerve, but the changes were so slight that the possibility of a subjective factor being concerned could not be neglected. In the attempt to obtain more distinct structural death changes other narcotics were used, and it was found that in ethyl ether the fibrillation almost completely disappeared and the strands became very distinctly granular in appearance in consequence of irregular swelling and varicosity of the fibrils. In 1 per cent. ether or somewhat lower concentrations these changes occur, slowly requiring several hours for completion, and a very distinct gradient in their occurrence is visible. The change from fibrillar to granular appearance begins at the two ends of the nerve very soon after it is brought into the solution, and a distinct gradient in this change can be seen extending a few millimeters peripherally from the central end and a shorter distance centrally from the peripheral end. This first change remains limited to the two terminal regions of the nerve and is undoubtedly associated with the stimulation and injury resulting from severing the nerve at these two points.

Later, however, the change begins to progress along the nerve from the central toward the peripheral end, but the change at the peripheral end progresses only very slowly or not at all in the central direction. From this time on a distinct gradient in the change is visible until it has progressed along the whole length of the nerve. Except in the terminal region adjoining the peripheral cut end the death change always progresses in the peripheral direction. The peripheral third of the length may be entirely unchanged at a time when the central third or more has completely lost its fibrillar appearance. When long strands are so arranged that central and peripheral regions are side by side in the same field of the microscope the differences between the two regions are very striking. If the nerve is crushed or injured at any point short gradients appear on both sides of the injury, but do not extend to any great distance before the general change reaches this region in its progress peripherally.

The existence of this centro-peripheral gradient in the death changes of the nerve fiber in narcotics must mean that a gradient of some sort exists in the living nerve and if the action of the narcotics is of the same character here as in other cases we must conclude that this gradient is associated with metabolism and that the rate of metabolism or of certain metabolic processes is in general higher at the central end and decreases peripherally in this nerve.

That metabolic gradients occur very widely if not universally, at least during the earlier stages of development in axiate organisms and structures, is evident from the data of embryology. The so-called law of antero-posterior development must be the expression of an axial metabolic gradient. And as regards plants there is a large body of evidence which indicates that the vegetative tip possesses a higher rate of metabolism than other regions of the same axis. Even in the unicellular body of the ciliate infusoria and in various other cells which show a morphological polarity the writer has observed a susceptibility gradient. In view of the facts it is impossible to doubt that such gradients are in some way closely associated with polarity in organisms, and various lines of experimental evidence which can not be considered here indicate that they constitute the dynamic basis of polarity. There are, moreover, many facts which suggest that the establishment of a gradient of this kind is the first step in individuation in axiate organisms.

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SCIENCE

FRIDAY, JANUARY 16, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CHARACTERIZATION AND CLASSIFICATION OF BACTERIAL TYPES[1]

THE vast majority of students of microbial life are preoccupied with immediately practical problems, and most of them have been trained for their work from the standpoint of some practical art, medicine, veterinary science, sanitary engineering or agriculture, rather than from the more general and fundamental standpoint of the biologist. The Society of American Bacteriologists was founded as a protest against such necessary but dangerous specialization, to bring together workers in all fields for a consideration of their problems in the light of the underlying, unifying principles of bacteriology as a member of the group of the biologic sciences. It is this ideal which distinguishes our society from any other organization in America which deals with microbic life and its effects.

It is of course fruitless to attempt to draw any sharp distinction between pure and applied science, and it would be a great pity if, as we gather year by year, we should fail to discuss together many of the more special problems of technique with which we are concerned. In particular it is well that we should exercise the widest hospitality toward those branches of our science, such as dairy bacteriology and soil bacteriology which have no technical societies at their disposal, such as are available for the specialists in medical and sanitary lines. We should be untrue to our highest mission, however, if we failed at the same time to emphasize those phases of our work in which this society of all others

[1] Presidential address, Society of American Bacteriologists, Montreal, Canada, January 1, 1914.

is peculiarly qualified to be of service, in striking sparks by the contact of experience in the different fields of bacteriology, and in viewing all our special problems by the clear light of fundamental biological principles.

The task of the biologist is the study of the reactions of the group of allied substances we call protoplasms, under the influence of various physical and chemical conditions of the environment. Instead of the pure compounds of the chemist we must deal with organisms, interacting mixtures of substances, different for each kind and even for each individual plant and animal. In very refined work such as is involved in the determination of reaction times by the psychologist or in our own studies of the action of disinfectants, even the personal equation of the individual or the individual strain must be taken into account. For most purposes, however, the species or kind of organism displays reasonably uniform characteristics, and may be used as our practical unit of study. A clear distinction between the kinds of organisms involved and a clear conception of the relation between these kinds is certainly however imperative, and a sound basis for the characterization and classification of the organisms with which we deal is one of the most pressing needs of bacteriology.

The fact that we have lacked in the past any sound system of sorting out and arranging bacterial types requires no elaborate demonstration. The question of what constitutes a colon bacillus has agitated sanitary bacteriologists for three decades and is still unsolved. And to take a still more striking and still more important case, consider the controversy as to the Vielheit or the Einheit of the streptococci, which has raged so long. Here is a group of organisms, the part played by which in a wide range of diverse diseases is found to be more fundamental—a group which I am inclined to think produces in the aggregate more suffering and death—than any other group, except the acid-fast bacilli. Yet we are almost wholly at sea in regard to their identification and mutual relationships.

There are two very distinct types of variations characteristic of organisms in general, fluctuations and mutations, and both are well recognized among bacteria. Fluctuations are the minor quantitative differences which group themselves on a curve of frequency when a large series of individuals is studied, as a rule due to the chance effects of environment and not inheritable. Thus, for example, Walker and I (Winslow and Walker, 1909) found that one hundred different subcultures of a single strain of the paratyphoid bacillus race *A* gave acidities in dextrose broth varying between 1.1 and 1.6 per cent. normal, while a similar series of lines of race *B* gave acidities varying between 1.3 and 1.9 per cent. normal. We took the subcultures of each type giving maximum and minimum acidities and isolated one hundred secondary subcultures of each. The curves from these extreme cultures however in spite of the diversity exhibited by their immediate parent stock, went back to the curves characteristic of their respective races, with a mean value of 1.4 for race *A* and of 1.6 for race *B* (Fig. 1). These fluctuating variations are clearly of no systematic significance and must be eliminated from consideration by a study of numerous strains of the same type.

It seems on the whole most convenient to limit the term fluctuations to such noninheritable variations as those just described. At times, however, we find in our cultures variations of apparently similar nature, but distinguished by the fact that selection among them does produce permanently different races. Thus, Goodman (1908) carried out experiments with the acid production of *B. diphtheriæ* somewhat

like those with the paratyphoid strains which have just been discussed, but leading to the ultimate separation of two strains of widely different fermentative power. Rettger and Sherrick (1911) report similar results in regard to the pig-

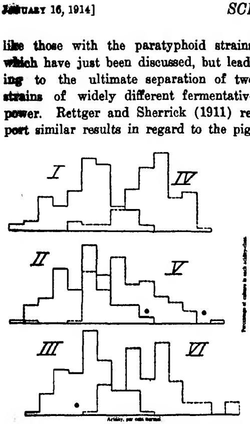

FIG. 1. ACID PRODUCTION BY PARATYPHOID BACILLI. (I.) Distribution of 100 original cultures, Type *A*. (II.) Distribution of 100 subcultures of descendants of maximum strain, Type *A*. (III.) Distribution of 100 subcultures of descendants of minimum strain, Type *A*. (IV.) Distribution of 100 original cultures, Type *B*. (V.) Distribution of 100 subcultures of descendants of maximum strain, Type *B*. (VI.) Distribution of 100 subcultures of descendants of minimum strain, Type *B*.

ment-producing power of some of the red chromogens and the resistance to mercuric chlorid of the *Aurococcus;* and in their paper the similar results of earlier observers are discussed. Such variations as these strongly suggest the pure lines of Johannsen and may perhaps for convenience be designated as pure line variations.

A distinct type of variation is the mutation, a definite sharp variation separated by a wide gap from the normal character of the type, arising spontaneously in a certain regular proportion of the individuals of a race. Barber (1907) has shown for example that peculiar filamentous chains of cells occur, rarely, but with considerable regularity, in cultures of *B. coli,* and that by isolating these filaments and breeding from them he could get a new race, constantly showing the filamentous arrangement and possessing definite cultural characters and a fermentative power considerably higher than the normal. Similar, though less conclusive results were obtained with *B. typhi,* and in one case an apparently non-spore-forming race was derived from *B. megatherium.* A particularly interesting case is that of the fermenting mutants of the typhoid group first observed by Neisser and Massini and recently thoroughly worked out by Penfold (1912). With a number of different strains of typhoid and paratyphoid bacilli and a number of different sugar media it has been shown that an organism which does not ferment the carbohydrate in question may produce on media containing it colonies which after several days bear curious raised papillæ. Subcultures from these papillæ yield a pure culture of a strain which resembles the parent stock in every respect, except that it actively ferments the specific carbohydrate and forms no papillæ; and this mutant breeds true. On the other hand subcultures from other parts of the parent colony produce strains which, like the original stock, do not ferment en masse, but do possess the property of throwing off fermenting mutants. Clark (1913) has recently shown that some at least of these modifications may have been quantitative only rather than qualitative, but the sharpness of the difference involved seems to warrant their recognition as true mutations.

Either fluctuations or mutations may originate as a result of protoplasmic in-

equalities in cell division and without any corresponding variations in environmental condition. Or, on the other hand, they may be causally related to changes in the chemical and physical surroundings of the organism as were those which MacDougal produced among the higher plants by injecting chemicals into the ovary and such as Tower caused by exposing potato beetles to special conditions of temperature and humidity. Changes of this sort are very familiar among the bacteria, as for example in the case of the increase in virulence on passage through susceptible animals, or the converse process of attenuation, as practised in the preparation of vaccines for anthrax and other diseases. Wolf (1909) reports a considerable number of temporary modifications and some permanently inheritable ones stimulated by exposing bacteria to the action of chemicals. White and dark red strains were thus produced from a normal *B. prodigiosus*, the resulting modifications breeding in each case true to their new type. Variations of this sort called forth by the direct effect of the environment I have been accustomed to distinguish by the term "impressed variations."

The net result of the various sorts of variability to which the bacteria are subject is to produce a condition, not different in kind, but more extreme in degree, than that which exists among more complex forms. As Bateson (1913) says: "The problem of species in its main features is presented by these organisms in a form identical with that which we know so well among the higher animals and plants." Several peculiar conditions tend, however, to make specific distinctions even more unstable among the bacteria than elsewhere. In the first place the action of the environment upon unicellular organisms is peculiarly direct and the fact that all cells are potentially reproductive removes any bar against the inheritance of acquired characters. Again the absence of sexual reproduction must operate to preserve variations which arise from within or without. Among sexual organisms it is true that amphimixis is held to be in itself an important source of germinal variations. Yet this is true only within certain rather definite limits and beyond those limits sexual reproduction ceases or becomes infertile and thus the more divergent variations are eliminated. With fission as the normal method of reproduction, on the other hand, every variation which can arise may be handed on, unchanged. Finally the rapidity with which the bacteria multiply furnishes exceptional opportunities for the operation of selection or any other modifying force. The immense number of generations which may succeed each other in a short space of time might be expected to make boundary lines as shifting as they would become among the higher plants if a dozen geological epochs were considered all at once.

There are sharp limits to the variability of even the bacteria however and for practical purposes we find the larger groups quite constant in their general properties. As a rule typhoid germs descend from typhoid germs and tubercle bacilli from tubercle bacilli. The same yellow coccus falls on gelatin plates exposed to the air, all over the world. The same spore-forming aerobes occur in every soil, the same colon bacilli crowd the intestines of animals and men in every clime. In part at least I am inclined to believe that this is due to the direct or selective effect of similar environmental conditions producing what Jordan and Kellogg call among higher organisms "Ontogenetic species held for a number of generations true to a type simply because the environment, the extrinsic factors in the development of all the individuals in these successive generations, are

the same." The comparative fixity of the more strictly pathogenic bacteria is a striking illustration of this tendency.

In many instances we find that individual strains of bacteria exhibit an extraordinary uniformity in minor characteristics even when (or perhaps particularly when) cultivated for long periods on artificial media in the laboratory. The two paratyphoid strains, *A* and *B*, described above offer a striking instance of this. The mean acid production of the two strains was respectively 1.4 and 1.6 per cent. normal, differing only by .2 per cent. normal and the fluctuating variations, extending over a range of over 1.0 per cent. in each case, far exceed the mean difference between the strains. Yet subcultures show each strain, as a strain, breeding true to its characteristic. We find slight differences in resistance to unfavorable physical condition or to the action of some chemical disinfectant transmitted unchanged in a particular strain for generation after generation.

As a matter of fact indeed it is not alterations in the characters of bacteria while we are studying them which generally trouble us, but the fact that as we isolate these organisms in nature we find that antecedent variations have produced a bewildering confusion of slightly differing varieties or races or strains. Between well-marked types like *B. coli* and *B. alcaligenes* is a series of forms, each one differing but slightly from its neighbor, but together almost completely bridging the gap between the two extremes. The more refined our methods of bio-chemical examination, the more the types are multiplied, and the more hopeless is the confusion. When Gordon (1905) applied his nine tests to 300 different strains of streptococci, he found 48 different combinations of reactions, and MacConkey (1909) records 36 different varieties of colon bacilli characterized by particular combinations of his seven tests To call each distinguishable strain having definite bio-chemical properties a species and to give it a name of its own, is quite out of the question. To ignore all minor differences and maintain as specific such complex groups as are included under the term *B. coli* or *Str. pyogenes* is misleading and an effective bar to future progress.

The first principle, which has proved of prime assistance in the characterization of bacterial types, and which offers a rational compromise between either false unity or bewildering multiplicity, is the recognition of the fact that types which occur commonly among bacteria as they are found in nature are of greater systematic importance than those which occur rarely and occasionally. Of course from one standpoint every inheritable protoplasmic variant which exists is of equal importance with every other. For practical purposes, however, we must recognize certain types as "species" or "varieties" even though they may sometimes intergrade. Among the higher plants and animals such systematic units are usually recognized on the basis of discontinuity in some definite character. The more refined methods of biometry have however revealed another grade of kinds (I use this word to avoid the artificial implications of "species" or "variety"), marked by relative rather than absolute discontinuity. Frequently the measurement of some particular differential character and the plotting of a "frequency polygon," with grades of the chosen character as abscissæ and the proportion of individuals showing each grade as ordinates, shows a curve with two distinct peaks, a bimodal curve. The studies reported by Bateson on the length of the cephalic horns of the rhinoceros beetle and on the forceps length of the earwig and De Vries's observations on the petals of a chrysanthemum, are excellent examples.

In each case the peaks on the curve indicate distinct centers of variation around which the intermediate fluctuations are grouped and these constitute biologic facts of real importance, even though the types overlap and appear to blend in the valleys between the modes.

Johannsen in his recent book (1913) has discussed such bimodal curves with admirable clearness and points out that obvious phenotypes (externally recognizable kinds) may or may not represent true genotypes (characterized by germinal differences),—

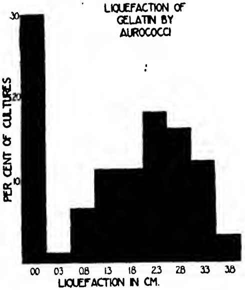

Fig. 2.

breeding experiments being the only final criterion. In our bacteriological work we are making breeding experiments all the time and even though our study of mass reactions may be crude, it is free from the grosser errors due to environmental variations, and our bimodal curves indicate real protoplasmic diversity. For example, in a study of the gelatine liquefying power of the orange cocci, it appeared that the depth of liquefaction after 30 days varied from 0 to over 3.5 cm., each intermediate .5 c.c. value being represented. Yet the frequency with which various grades of liquefaction occurred showed that only two distinct types were common (Fig. 2), one failing entirely to liquefy, including 30 per cent. of the strains studied, and the other liquefying rapidly, to the extent of 2.0–3.5 cm., including 45 per cent. of the strains. Ordinarily such a difference in proteolytic power as that between a liquefaction of 1.0 cm. and one of 3.0 would be considered important as marking a distinction between a very slowly and a rapidly liquefying type. Yet in view of the frequency curve it is both practically convenient and biologically sound to say that we are dealing with two and only two distinct types, so far as this character is concerned, one not liquefying at all and the other liquefying vigorously to an extent of 2.0–3.5 cm. in 30 days, while slowly liquefying strains may be considered as aberrant varieties.

Another example of this conception of frequency types may be taken from recent studies of the fermentative power of the colon bacilli and the streptococci. Both these groups have been split up according to their acid-producing power in a wide variety of carbohydrate media and any one sugar has been considered just as important as any other, giving almost as many types as there are permutations and combinations of the test substances used. Howe (1912) has shown for the colon bacilli, and the same thing is true for the streptococci (Winslow, 1912), that the various carbohydrate media are not fermented at random, but stand to each other in a definite "order of availability" forming what Howe calls a "metabolic gradient," such that if any member of the series is fermented the chances are that those ahead of it will be fermented also. Thus in the colon group dextrose is most often attacked, then lactose, then saccharose and then raffinose. Certain steps in the gradient are qualita-

tively far more important than others. Of 540 dextrose fermenting bacilli freshly isolated from the intestine Howe found that practically all attacked lactose. Saccharose divided the group into two approximately equal subgroups, 58 per cent. attacking this sugar and 41 per cent. failing to do so. Of the 58 per cent. all but 5 per cent. also attacked raffinose so that the dextrose-lactose-saccharose forms may be considered intermediate variants between the two main divisions which ferment either dextrose and lactose alone or all four sugars (Fig. 3). It seems clear that such quantitative studies furnish the surest basis for deciding which sugars are primarily important in classification and we may safely conclude that so far as these four sugars are concerned there are only two important divisions of the colon group. The use of dulcite which occupies an equally prominent place in the classification of MacConkey (1909) and Jackson (1911), rests on no such biometrical basis and we have no good reason to think it deserves special importance. In the same way the admirable study by Stowell, Hilliard and Schlesinger (1915) of the streptococci shows that the five groups fermenting respectively dextrose only, dextrose and lactose, dextrose, lactose and saccharose, dextrose, lactose, saccharose, and raffinose and dextrose, lactose, saccharose, raffinose and salicin are quantitatively of special importance and include between them 68 per cent. of 240 strains studied.

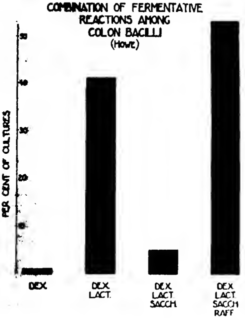

Fig. 3.

A second conception, of much assistance in the classification of bacteria, is the principle that special weight should be given to characters quantitative or qualitative, which are found to be correlated with each other in a number of different types. The principle of numerical frequency offers a basis for characterizing the individual types and the principle of correlation a basis for classifying these types in accord with their biological relationships.

The early bacteriologists established a dozen genera, such as *Streptococcus, Sarcina, Bacillus, Bacterium,* and the like, based entirely on a few obvious morphological characters. Some of these genera are undoubtedly valid. Others like those which are based only on the presence or absence of flagella are quite as certainly invalid. No one familiar with the colon group can hold that it is reasonable to place the common type of motile colon bacillus in the genus *Bacillus* along with *B. mycoides, B. aerogenes, B. anthracis, B. prodigiosus, B. radicicola* and *B. tetani* and to place an organism having all its other properties identical but lacking flagella in the genus *Bacterium.* The same arguments hold true against the genera *Planococcus* and *Planosarcina* among the cocci. We find in several of the major groups motile and non-motile forms which are precisely alike in half a dozen respects and are clearly minor varieties of the same

type, and it is absurd to give them generic rank, and group together widely different types which are alike in no single respect except that they have flagella. These genera based on motility are on a par with a division of animals into those with wings and those without, which would place bats and birds and flying fishes and bees in one group and cats and ordinary fishes and worker ants in another.

The unsatisfactory nature of the Migula classification, which, even if the motility genera were accepted, left over one third of all known bacteria in the genus *Bacillus*, led many bacteriologists to abandon any attempt at a natural classification and to seek refuge in frankly arbitrary schematic groupings. The logical outcome of this tendency is the decimal group number which our society has adopted, the history of which has been so ably presented by Professor Harding (1910).

The group number, according to which the characters of bacteria are indicated by a conventional series of decimals, has an undoubted value and has proved a godsend to workers who study a large series of new cultures and desire a concise record of their behavior. It is a sort of index to the chief characters of the organisms in question, a method of cataloging reactions observed. It is obvious however that it is artificial, and that it does not furnish a "classification," an arrangement of bacteria according to their natural relationships.

There is some danger, I think, that this important distinction between the group number on our standard card and a real biological classification may be forgotten. When the student notes that 100 means that endospores are produced and 200 that they are not produced, he is likely to draw the conscious or subconscious conclusion that all bacteria producing endospores are more closely related to each other, are more of a kind, than are the members of the two separate groups. I think that this is very probably a fact. Then, of the non-spore formers, he notes that strict aerobes fall under 210, strict anaerobes under 230 and facultative forms under 220. Again he is likely to draw a similar conclusion as to relative relationships and again perhaps the conclusion is reasonably correct. In the third place of the whole numbers, however, any such deduction as to natural relationships from the group number would certainly be erroneous. Of the facultative non-spore formers, all which liquefy gelatine fall under 221; and all which fail to do so under 222. That is, the group number throws together on the one hand *B. cloacæ* and the liquefying strains of fluorescent water bacteria and the liquefying proteus forms, and on the other hand *B. coli* and the non-liquefying fluorescent and proteus types. It is reasonably certain however that liquefying and non-liquefying fluorescent bacteria are more closely related to each other, that *B. coli* and *B. cloacæ* are more closely related to each other, that liquefying and non-liquefying proteus types are more closely related to each other than are the liquefying or the non-liquefying members of the three respective pairs. Precisely as in the case of Migula's motility genera the use of a single arbitrarily chosen character in classification leads to misleading results.

It is sometimes held that the difficulties we experience in bacterial classification are due to the fact that we must necessarily rely in the main on physiological rather than on morphological characteristics. I do not believe this to be the case. There is no fundamental distinction between morphological and physiological properties, since all are at bottom due to chemical differences in germ plasm, whether they happen to manifest themselves in the size and arrangement of parts or in the ability

to utilize a certain food stuff. Indeed biochemical properties have a peculiar and unique significance among the bacteria, since it is precisely along the lines of metabolism that these organisms have attained their most remarkable differentiation. The higher plants and animals have developed complex structural modifications to enable them to obtain food materials of certain limited kinds. On the other hand the bacteria have maintained themselves by acquiring the power of assimilating simple and abundant foods of varied sorts. Evolution has developed gross structure in one case without altering metabolism; it has produced a diverse metabolism in the other case, without altering gross structure. There is as wide a difference in metabolism between the pneumococci and the nitrifying bacteria as there is in structure between a liverwort and an oak. The danger in using physiological characters for classification lies, not in their inherent unreliability, but in the fact that so many physiological properties are directly adaptive in nature. Adaptive characters of similar nature are likely to arise in different groups under the influence of similar environmental conditions and may prove altogether misleading as to true phylogenetic relationships. Professor Gadow in his striking address before the British Association has called the independent evolution of a nearly identical character from homologous material isotely. We have excellent examples among the bacteria. It seems clear for example that we must assume from the presence of liquefying and non-liquefying types among so many of the principal groups of bacteria that this property has lain latent in a great many independent lines of descent and has been independently released in many of them, perhaps by environmental forces. It is particularly to avoid this danger of confusing independently acquired adaptive characters with those which indicate real community of descent that we must lay stress on the significance of a number of independent characters which occur in correlation. If the correlation is due to an essential dependence of one character upon the other it is of course not particularly significant; but, when we find a number of different characters, which have no necessary connection, correlated together, the presumption is warranted that common descent is the connecting link which has united them.

It was in the study of the Coccaceæ that the full importance of emphasis on correlated characters first impressed itself upon me. It had long been the practise, following the Migula system, to group all the staphylococci of the skin and the saprophytic cocci which divide in one and two planes together in the genus *Micrococcus* and to separate the packet-formers in the genus *Sarcina*. The common cocci found on the skin, all liable to assume at times pathogenic properties, were usually classed as merely three color varieties (*aureus*, *albus* and *citreus*) of a single species *Micrococcus* or *Staphylococcus pyogenes*. In the attempt to apply statistical principles to the classification of this group,[1] Mrs. Winslow and I collected and studied 500 different strains of cocci, measuring quantitatively so far as possible eleven different characters of each strain. At once a new and surprising set of relationships manifested themselves. It was evident in the first place that on the whole the cocci living normally on the body surfaces, differed in almost every respect from the cocci

[1] First published in Biological Studies by the Pupils of William Thompson Sedgwick, June, 1906, and in the *Journal of Infectious Diseases* for the same year and later elaborated in our book on the "Systematic Relationships of the Coccaceæ," N. Y., 1908.

of the water and earth. The former usually occurred in chains or small irregular groups, reacted positively to the Gram strain, formed a meager or only fair surface growth on solid media,[7] and produced considerable acid in carbohydrates. The cocci of the water and earth occurred in large cell groups or packets, never in chains, were usually Gram negative, grew abundantly on solid media and generally failed to ferment carbohydrates. There were exceptions of course, as there always must be in an unstable group like the bacteria. Some organisms which a general consideration of all their characters would place in the latter group were found on the skin, while others were Gram positive or fermented the sugars. Yet on the whole the relation seemed a sufficiently definite one to warrant the division of the spherical bacteria into two subfamilies, the Paracoccaceæ and the Metacoccaceæ. The next thing which was apparent was that the color of the pigment produced, instead of being a minor varietal character, was fundamentally correlated with other properties which were apparently of sufficient importance to deserve generic rank. It appeared that the orange and white staphylococci, along with the diplococci and streptococci, all shared the properties of the Paracoccaceæ just enumerated, while the yellow and red pigment formers (in spite of the occasional presence of the former on the skin and even in connection with pathological processes) exhibited the characters of the Metacoccaceæ (Fig. 4). The white and orange forms further differed from each other in the fainter surface growth of the former and in the important fact that liquefying members of the orange series liquefy twice as rapidly as do the liquefying white strains. Hence we distinguished these groups as the genera *Aurococcus* and *Albococcus*. Among the Metacoccaceæ the yellow and red forms were sharply separated by the much higher proportion of strains which reduce nitrates to nitrites and by the absence of ammonia formation in nitrate pepton broth and by the rarity and slowness of liquefaction, among the red chromogens, for which we

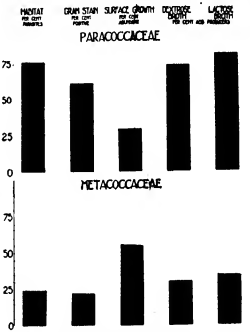

FIG. 4. GROUP DIFFERENCES BETWEEN THE PARACOCCACEÆ AND THE METACOCCACEÆ. The upper blocks show for 221 strains of cocci whose type of chromogenesis (white or orange) would place them with the parasitic subfamily, the per cent. of strains fulfilling each of five individual criteria of that group. The lower blocks show for 279 strains of cocci whose type of chromogenesis (yellow or red) would place them with the saprophytic subfamily the per cent. of strains fulfilling each of five individual criteria of that group.

suggested the generic name *Rhodococcus*. The important point brought out by these studies was that chromogenesis and the Gram strain, characters which we all had believed to be comparatively unimportant, proved to be correlated with a number of other properties and therefore highly significant. On the other hand the Migula

distinction between *Micrococcus* and *Sarcina* appeared to be of quite minor importance. Among the yellow chromogens we found a completely parallel series of packet-formers and non-packet formers exactly alike in all other respects. So with liquefaction of gelatine. Among aurococci, albococci, micrococci and sarcinæ were strains having all other properties in common, but differing in this one respect. Kligler (1913) has recently examined the cocci in the American Museum collection and has found that the fifty strains represented fall very clearly in the genera thus outlined, although he concludes that the species originally described should be modified in certain important respects.

The general principles of statistical classification were outlined as follows by Miss Rogers and myself (1906):

> We have first plotted the frequency curve for each character in order to find whether the array varies about one or several modes, and where these modes are situated. . . . In the second place, we have calculated correlation factors for the most significant pairs of characters. Each mode on the curves of frequency may fairly be taken to mark a natural species or variety, and the characters which vary together must form the most important basis for the establishment of the larger groups. By such a method alone it is possible to locate those mountain peaks in the chain of bacterial variations which rightly deserve generic and specific names.

In the same year in which this paper was published, Andrewes and Horder in England presented a revision of the species in the genus *Streptococcus* (1906) based on exactly identical principles at which they had independently arrived. They say:

> There was, however, one guide which, as in all such taxonomic problems, proved of the greatest help, namely, the numerical frequency of occurrence of any given type. . . . The common types stand out as mountain tops above their fellows, each mountain connected by valleys of intermediate types with many of its neighbors.

Since these suggestions were first made, the statistical method has been systematically applied by Howe (1912) to the colon group, by Stowell, Hilliard and Schlesinger (1913) to the streptococci, by Dr. Morse (1912) to the diphtheria group and by Rogers and Davis (1912) to the lactic acid groups.

There are many other serious investigations of bacterial relationships which might be cited, many of them made before the term "statistical classification" was thought of in this connection, but characterized by the fact that they include a careful comparative study of many different strains with due regard to the frequency with which types occur and to the special importance of correlated characters. Among the earlier investigations, Beijerinck's study of the acetic acid bacteria (1898), Chester's on the aerobic spore formers (1904) and Hefferan's on the red pigment producers (1904) are worthy of special mention. More recently Edson and Carpenter have given us an excellent revision of the group of fluorescent bacteria (1912). Owen (1911) has added much to our knowledge of the aerobic spore formers, White (1909) has revised the *B. bulgaricus* group and Dr. Claypole (1913) has worked out some very striking correlations between immunity relations and cultural characters among the streptothrices. The elaborate study of the dysentery group by the late Dr. Hiss (1904) and Elser and Huntoon's review of the Gram-negative cocci (1909) should also be mentioned in this connection. There has already been accumulated a considerable mass of data which when critically examined and codified should furnish a good basis for a systematic arrangement of many of the smaller bacterial groups.

So far as the general classification of the bacteria into larger groups, families and

genera, is concerned, we have also, I believe, plenty of information which if properly digested would make it possible to arrive at reasonable and helpful results. With these large groups no special statistical study is generally necessary, for the chief characters of the major types are well established. All that is needed is interpretation, but interpretation based on a view of all the available facts and on a sound conception of biological principles. Until recently the only attempt at a general classification of the bacteria based on a common-sense interpretation of all the characteristics of the organisms is that presented by Flügge (1896), the chief value of which lay in the classification of the rod-shaped bacteria into 22 groups, almost all of which appear to represent natural aggregations of allied types. For example, we all recognize that the aerobic spore formers, the anaerobic spore formers, the colon-typhoid group, the nitrifying organisms, the fluorescent bacteria, and the group of diphtheria and tubercle bacilli constitute real groups of related organisms.

Four years ago a more ambitious attempt at a fundamental analysis of the systematic relationships of the whole group of bacteria was made by Professor Orla Jensen, of the Polytechnicum of Copenhagen (1909). Professor Jensen with good reason discards the purely morphological basis of classification and in particular the distinction based on the presence or absence of flagella. The arrangement of flagella when they are present, on the other hand, offers a convenient index of other more important differences and Professor Jensen gives his two orders of bacteria the names of Cephalotrichinæ (monotrichous or lophotrichous) and Peritrichinæ (peritrichous). The Cephalotrichinæ, deriving their life energy almost entirely from oxidative processes, are all water or moist earth forms, with the exception of a few peculiar plant and animal parasites and for the most part grow badly or not at all on ordinary organic media, and spores are never formed. The series begins with the Oxydobacteriaceæ, including the most primitive bacteria, which oxidize methane and carbon monoxid, the nitrifiers, the acetic acid bacteria and the Azotobacter group. Then follows the Actinomyces family which includes the root nodule bacteria and the mycobacterium (tuberculosis) group. The collocation of the latter forms is startling at first, but their morphology, their oxygen requirements and their unique pathological relations, almost symbiotic by contrast with the quick toxic action of other pathogenic bacteria, offer some evidence of real relationship. The third, fourth and fifth families are the Thiobacteriaceæ (the sulfur bacteria), the Rhodobacteriaceæ (the red or purple sulfur bacteria) and the Trichobacteriaceæ (*Cladothrix*, *Crenothrix*, *Beggiatoa*, etc.) which are clearly natural groups. The last two families, the Luminibacteriaceæ and the Reducibacteriaceæ, are typically denitrifying organisms which form a connecting link between the primitive oxidizing bacteria and the Peritrichinæ. They include the fluorescent water bacteria and the phosphorescent vibrios and at the higher end of the series such forms as the cholera organism in which the ability to split complex products with the formation of lactic acid and indol begins to appear.

The second order, the Peritrichinæ, includes the more specialized bacteria in whose metabolism the splitting of carbohydrates or amino-acids plays a primary rôle rather than oxidation or denitrification. They are rods or cocci, peritrichous when possessing flagella at all, and among them are found all the commoner putrefactive and parasitic types. This order, according

to Jensen, may be divided into four families. The first, the Acidobacteriaceæ, includes the non-spore-forming carbohydrate fermenting types, among the principal representatives being the colon-typhoid group and practically all the cocci. His second family, the Alkalibacteriaceæ, shows a higher development of the power of decomposing nitrogenous bodies, and includes the liquefying proteus forms, the actively liquefying aerobic spore formers and certain urea fermenters. The last two families, the Butyribacteriaceæ and the Putribacteriaceæ, are made up of the strict anaerobes.

Whatever minor criticisms may be made of Professor Jensen's scheme, I believe that no one who has thought seriously about bacterial relationships can study it carefully without feeling that it is by far the most successful attempt yet made at a real biological classification of the group and that future progress will probably consist in its modification and extension rather than in any profound reversal of its basic principles.

Inertia in terminology is strong and it is the business of no one in particular to criticize and report on the value of suggestions as to bacterial classification and nomenclature. We are all too busy with our own special field to undertake such a task of our own accord. Yet I believe that in the present state of bacteriology such a critical examination of suggested systematic arrangements is most essential. A mass of work has been done in the last ten years, potentially valuable, but almost useless so long as it remains a sealed book to all but its respective authors and their pupils.

What we need at this time is a court of appeal on matters of systematic bacteriology, a court to which all suggested classifications, past and future, may be referred for official acceptance or rejection, in whole or in part. Such a court or commission might take first Professor Jensen's classification as the most recent comprehensive attempt to treat the whole group of the bacteria, and after careful consideration might adopt such of his families and genera as seem well established and issue a report in which they should be definitely and clearly defined. Such a report from a commission of a proper caliber would not be ignored as work of any single worker may be, but would be adopted and would become at once a part of the practical working machinery of our science. The genera and species suggested for the Coccaceæ, the Andrewes and Horder species of the genus *Streptococcus*, Chester's species of spore-bearing aerobes, Dr. Morse's types of pseudo-diphtheria bacilli, Edson's types of fluorescent bacteria, etc., might be later taken up so that ultimately a complete scheme of bacterial classification would be at our disposal.

Such authoritative commissions on classification and nomenclature are well established in the older biological sciences, as for example, the International Commission on Zoological Nomenclature appointed by the Third International Zoological Congress in 1895 and made permanent at the Fourth Congress in 1898. Its work has been much more along the line of precise legal definitions and the determination of priority in terminology, than would be the case with a similar commission in bacteriology. The broader constructive work which has already been accomplished in zoology still remains for us to do. Furthermore we have no international congress to which such a commission could profitably report on all the phases of its work, although for one group of the bacteria, the colon-typhoid group, a commission on systematic relations was created by the last International

Congress on Hygiene and Demography, of which Dr. Weber, of Berlin, is chairman and the president and two past presidents of this society are the American members. I believe this to be a fitting time for a more far-reaching attempt to criticize and collate and systematize the work which has been done in many countries and by many observers on the characterization and classification of bacterial types. The inception of such a plan may very properly come from the Society of American Bacteriologists which through its standard card has already done so much for the development of the purely descriptive side of our science. As a practical outcome of this long survey of the problems of systematic bacteriology, with which you have borne so patiently, I suggest that we invite fifteen bacteriologists from the principal scientific countries to act as an international commission on the characterization and classification of bacterial types, with the general objects outlined above. If you should approve this plan, and if we can secure the cooperation of investigators of the first rank (as I have no doubt will be the case), I believe that we can thus render to bacteriology a great practical service, worthy of the highest aims which our society has held in view.

C.-E. A. Winslow

American Museum of Natural History

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ACADEMIC STUDENT ELECTIONS

In Science, October 24, 1913, are some interesting tables exhibiting the results of much patient work by Dr. Frederick C. Ferry, dean and professor of mathematics in Williams College. His tables give the registration of students taking various subjects of study in eighteen American colleges and universities. These subjects are commonly divided into three groups, roughly determined by the nature of the topics included. Thus, group I. may be called the "language group"; group II., the "humanities group"; and group III., the "science group." The distribution of work in each of these groups in any given college affords some indication of the popularity of the group. To express this distribution it is necessary to give, as Dean Ferry has done, for each subject the number of "student hours of instruction." In view of the great variation in total attendance at different colleges Dean Ferry has reduced his figures to percentages, on a semester basis, limiting them to undergraduates in the academic college.

On examining Dean Ferry's tables the present writer perceived the possibility of making the comparisons somewhat more pointed, and of securing a fair representation of popularity not only for groups but for separate subjects of study. A "student-hour of instruction" may be interpreted to mean one hour per week in the classroom, taken by one student throughout one semester. The actual work done includes an estimated pair of hours spent in study in preparation for the work of the classroom. This estimate is often not realized, the student taking his chances of escaping a test, especially if the class is rather large. Two or three hours in the laboratory are hence fairly counted as the equivalent of one hour in the classroom. Let h denote the value in student-hours for a given course; for example, if the student has 3 meetings per week in the classroom and 2 afternoons per week in the laboratory, then $h = 5$. Let n denote the number of students taking this course during a given semester; then nh denotes the work done in this course.

Now. let $\Sigma(nh)$ denote the work done in the sum of all the courses of a given subject; for example. there may be four courses in physics. Let A denote the whole academic work in stu-

dent hours done in all subjects in the college during a semester. Then the quotient of $\Sigma(nh)$ by A yields a percentage, p, that expresses the numerical demand for this special subject by the students, on the assumption that there is freedom of election of studies. Various local considerations apart from the nature of the subject are often operative in determining the student's election; such as the personal popularity of the professor and the reputation of his courses for ease or difficulty. English, for example, may be a "soft snap" under one professor and a formidable stumbling block under another. The evils connected with freedom of election, especially for freshmen and sophomores, are increasingly appreciated by educators; so that the assumption of unlimited freedom is now, happily, not quite warranted. for a semester. If the value of p for a selected subject is found in eighteen or twenty different colleges, the average of these values may be expressed by P. This average will of course be affected with enough uncertainty to be expressed as an integer. Thus, if the numerical popularity of French comes out as 8.74, and of physics as 4.37, the corresponding percentages would be taken as 9 and 4, respectively; indicating that out of the work done in these colleges about 9 per cent. may be expected to be in French, and about 4 per cent. in physics; or that the popularity of French is more than double that of physics, though the exact numerical results, 8.74 and 4.37, would seem to indicate an exact ratio of 2 to 1, which has to be taken with some grains of allowance.

TABLE OF PERCENTAGES

	p (max.)		P	p (min.)	
Group I.:					
Greek	Yale,	3.91	2	Wisconsin,	0.41
Latin	Bryn Mawr,	12.87	5	Harvard,	1.89
Germanic Languages	Wisconsin,	12.85	8	Princeton,	4.49
Romance Languages	Dartmouth,	13.28	4	Oberlin,	5.75
24.50			29		
Group II.:					
English	Mt. Holyoke,	21.84	16	Stanford,	10.46
History	Yale,	12.88	9	Amherst,	4.79
Political Science	Cornell,	12.75	5	Oberlin,	2.02
Economics	Harvard,	12.65	7	Amherst,	2.98
Philosophy	Columbia,	12.59	6	Stanford,	2.92
Bible	Wellesley,	8.01	4	Princeton,	0.06
46.78			47		
Group III.:					
Mathematics	Princeton,	11.46	8	Bryn Mawr,	2.04
Astronomy	Mt. Holyoke,	1.87	1	Wisconsin,	0.11
Physics	Johns Hopkins,	7.54	4	Oberlin,	1.20
Chemistry	Cornell,	12.95	6	Wellesley,	1.84
Biology	Wesleyan,	13.36	5	Bowdoin,	2.55
Geology	Wisconsin,	4.24	2	Smith,	0.53
28.72			26		
100.00			97		

But the student who aims at a bachelor's degree finds himself often put to the necessity of choosing between what he regards as evils. By taking an average of such elections in a considerable number of colleges the personal element is to some extent eliminated.

The percentage, p, is obviously a rate, substantially the same for an annual session as

In the accompanying table these integral percentages are given in the middle column, as the result of studying Dean Ferry's tables. To show the range of variation the maximum and minimum values of p are additionally tabulated, along with the names of the corresponding institutions. Thus, the popularity of Greek is greatest at Yale and least at Wis-

cession. Nearly 4 per cent. of the academic work at Yale is in Greek, while at Wisconsin it is less than half of one per cent. The general popularity of this subject in the eighteen institutions compared is seen to be 2 per cent. The eighteen institutions selected by Dean Ferry are Amherst, Bowdoin, Bryn Mawr, Columbia, Cornell, Dartmouth, Harvard, Johns Hopkins, Mount Holyoke, Oberlin, Princeton, Smith, Stanford, Wellesley, Wesleyan, Williams, Wisconsin and Yale.

In making out the present table a number of subjects of small popularity have been excluded, such as Sanskrit, Slavic languages, archeology, anthropology, art, music, Semitics, Egyptology, veterinary science, history of science, etc. Their total value is 3 per cent., so that the sum of the recorded work for column *P* is 97 instead of 100; but, for each subject included, the value of *P* was made out on the basis of 100. The total for group I., as recorded in Dean Ferry's table, is seen to be 24.50 instead of 24; for group II., 46.78 instead of 47; for group III., 28.72 instead of 26. It will be noted that everywhere the tendency seems to be for students to crowd their work into group II., the amount of work taken in this group being nearly as great as in both of the other groups put together. Apart from the interesting humanistic character of the subjects included, they are wholly free from the intricacies of grammar and especially of mathematics.

English naturally leads in importance, with 16 per cent.; and mathematics, in spite of its rigors, presents 8 per cent. These high rates are partly accounted for by the fact that in most, if not all, American colleges these two subjects are prescribed, at least for freshmen; so that here the assumption of freedom of election is in large measure to be discarded.

For the 16 subjects represented in the table, with total value 97, the average percentage obtained by dividing 97 by 16 is a little over 6. This number may hence be taken as a rough standard for comparing the student demand for different subjects; or, for the average extent to which a subject may be studied, whether prescribed or elected. This average of 6 per cent. is not reached by astronomy, Greek, geology, physics, Bible, Latin, political science or biology. It is reached by philosophy and chemistry. It is exceeded by economics, Germanic languages, mathematics, Romance languages, history and English.

The table shows that the study of astronomy, so nearly universal in the senior classes of American colleges two generations ago, has now nearly vanished, being only half as much pursued as that of Greek; and this in turn was a subject of the first importance among our grandfathers. The popularity of astronomy is expressed by 1.87 at Mount Holyoke, a woman's college, where the teaching of this subject seems to be conducted with much pedagogic skill. It is least at Wisconsin, where the percentage number is only 0.11, despite the fact that the professor in charge, a man of international reputation, has done much original work.

Geology, a department of science which, as taught in our colleges, can not be compared with astronomy in mathematical difficulty, seems to maintain in these a degree of popularity about the same as that of Greek, 2 per cent., or one third of that of chemistry and of philosophy.

Physics and Bible study are apparently of equal popularity, about half of that of mathematics, and two thirds of that of chemistry. The demand for Bible study is by far greatest in institutions for women. It is expressed by 8.01 at Wellesley; 6.62 at Mount Holyoke; 5.88 at Oberlin. It is only 0.21 at Yale, where Y. M. C. A. influence is most widely diffused and voluntary attendance on morning chapel exercises throughout the annual session is maintained by popular demand. It is only 0.06 at Princeton, the presbyterian stronghold, which is fortified additionally by the power of the adjacent theological seminary.

The average percentages just discussed should be interpreted only as variables which indicate the modern academic trend. The range of variation for the particular list of colleges compared is worth noting in the first and last columns of the table. In every indi-

vidual college it may be expected that local influences will produce marked deviations from the indications of the table. But, none the less, the figures seem to be of enough educational value to be published.

W. Le Conte Stevens

Washington and Lee University,
December 24, 1913

SCIENTIFIC NOTES AND NEWS

Professor Theodore Richards, of Harvard University, has been elected president of the American Chemical Society for the year 1914. M. T. Bogert and A. D. Little have been elected directors and C. H. Herty, Julius Stieglitz, L. H. Baekeland and W. L. Dudley councilors-at-large for a three-year period.

Professor R. S. Woodworth, of Columbia University, was elected president of the American Psychological Association at the recent New Haven meeting. Professor R. M. Ogden, of the University of Tennessee, was elected secretary for a three-year period.

At the recent Princeton meetings, Dr. George F. Becker, of the U. S. Geological Survey, was elected president of the Geological Society of America, and Professor A. P. Brigham, of Colgate University, was elected president of the American Society of Geographers.

The Society of American Bacteriologists, at its Montreal meeting, elected Professor Charles E. Marshall, of Amherst, to the presidency and Professor F. C. Harrison, of MacDonald College, to the vice presidency.

It is proposed to present to the Royal Society a portrait of the retiring president, Sir Archibald Geikie, the distinguished geologist. A committee, with Sir William Ramsay as chairman, has been formed to collect subscriptions, which it is agreed should not exceed three guineas.

Professor W. B. Scott, of Princeton University, and Professor E. L. Trouessart, of Paris, corresponding members of the Zoological Society of London, have been elected foreign members of the society. Professor E. Ehlers, Göttingen, Mr. J. H. Fleming, Toronto, and Dr. C. Gordon Hewitt, Ottawa, have been elected corresponding members of the society.

Dr. Albert Ernest Jenks, professor of anthropology in the University of Minnesota, has been granted leave of absence from the university the second semester of the current year. Certain aspects of ethnic amalgamation, and environmental influence will be given field study. He will spend February and March in the southern part of the United States, and the next five months in Europe and northern Africa.

At a meeting of the State Geological Commission of Oklahoma late in December, the resignation of D. W. Ohern as director of the Oklahoma Geological Survey was accepted. L. C. Snider, the assistant director, declined to consider the directorship and C. W. Shannon, field geologist, was appointed director. The personnel of the scientific staff of the Survey as now constituted is as follows: C. W. Shannon, A.B., A.M. (Indiana), director; L. C. Snider, A.B., A.M. (Indiana), assistant director; L. E. Trout, A.B., A.M. (Oklahoma), field geologist; Wm. A. Buttram, A.B. (Oklahoma), chemist.

A series of three lectures has been planned for the classes of blind children that visit the American Museum of Natural History. In the first of these on December 18, Admiral Robert E. Peary recounted some of the experiences of his memorable Arctic journey which resulted in the attainment of the North Pole.

The Herter Lectures of the University and Bellevue Hospital Medical College will be given during the week beginning January 12, 1914, at Carnegie Laboratory, 338 East 26th Street, New York City. Professor Sven Hedin will lecture on "Colloids and their Relation to Biological Chemistry."

At a recent meeting of the Abernethian Society at St. Bartholomew's Hospital, London, Sir William Osler delivered an address on "The Medical Clinic—a Retrospect and a Forecast."

Professor E. M. East, of Harvard University, delivered in December a lecture entitled

"The Improvement of Plants by Hybridization" before a joint meeting of the "Garden Association" and the Horticultural Society of Newport, R. I.

AT the Dropsie College for Hebrew and Cognate Learning, Philadelphia, Dr. Ignaz Zollschan, of Vienna, will deliver three lectures on January 14, 15 and 19 on "The Cultural Value of the Jewish Race," "The Significance of the Mixed Marriage" and "Tendencies of Economic Development Among the Jewish People."

The Journal of the American Medical Association states that on December 11, the day on which he would have completed his seventieth year, there was instituted a quiet memorial in memory of Robert Koch by Professor Loeffler, the present director of the Institute for Infectious Diseases in Berlin, in the Robert Koch mausoleum. The entire board of directors of the Robert Koch foundation for the campaign against tuberculosis took part in the celebration. Memorial wreaths were placed in the mausoleum by this as well as other corporations, and in honor of the memorial day the *Deutsche medizinische Wochenschrift*, the regular organ of publication of the great bacteriologist, issued a special number to which interesting contributions were furnished by the most noted pupils of Robert Koch, Loeffler, Ehrich, Brieger, H. Kossel, Uhlenbuth, Pfeiffer, Kolle and others.

SIR JOHN BATTY TUKE, Unionist member for Edinburgh and St. Andrews Universities 1900–1910, the authority on mental diseases, left to the Royal College of Physicians, Edinburgh his bust by John Hutchison.

IT is proposed to place a tablet suitably inscribed to commemorate Benjamin Franklin in the Church of St. Bartholomew the Great, West Smithfield—the parish in which he worked as a printer. Subscriptions for this memorial may be sent to Mr. E. A. Webb, 60 Bartholomew Close, London, E.C.

PROFESSOR WINSLOW UPTON, head of the astronomical department of Brown University, and director of the Ladd Observatory, died on January 8, aged sixty-one years.

THE twelfth general meeting of the Association of Economic Biologists was held at Liverpool on December 30 and 31.

DR. TEMPEST ANDERSON, known for his studies of volcanoes, has left £50,000 to the Yorkshire Philosophical Society, of which he was formerly president, and £20,000 to the Percy Sladen Memorial Fund, established by his sister, Mrs. Sladen, in 1904.

THE family of the late Dr. Javal, the distinguished ophthalmologist, has given to the Eye Clinic of the Paris Hôtel-Dieu the fine library which he had collected in his ophthalmological laboratory at the École des Hautes Études in the Sorbonne. Madame Javal has completed the large collection of French and foreign periodicals up to the end of 1913.

SIR ARTHUR EVANS has, as we learn from *Nature*, presented to the museum at Cambridge the last instalment of an interesting set of objects selected from the collections of his father, the late Sir John Evans. The gift consists of 121 specimens ranging in date from prehistoric times to the eighteenth century. The value of the collection is greatly enhanced by the fact that all the specimens composing it were found in Cambridgeshire and the adjacent counties.

IN the alcove of the North American archeology hall of the American Museum of Natural History a mural series has recently been completed. It consists of five polychrome frescoes, three of which are enlarged copies of the frescoes on the walls of the cavern of Font-de-Gaume in France and two are enlarged copies from the ceiling of Altamiar in Spain. The originals of these represent paleolithic art at its highest point of perfection. The copies were made by Mr. Albert Operti.

DR. CARLOS DE LA TORRE of the University of Havana, Cuba, has made a very interesting and valuable addition to the collection of conchology in the department of invertebrate zoology. This material was secured by Dr. F. E. Lutz in his recent visit to Cuba and consists of land shells, many of which are described by Dr. La Torre.

The faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, on Sunday afternoons, beginning January 4, and ending May 10, 1914. The lectures, which begin at four o'clock, are as follows:

January 4. "Recent Studies of the Bodily Effects of Fear and Rage," by Dr. W. B. Cannon.

January 11. "Rational Infant Feeding," by Dr. John Lovett Morse.

January 18. "The Effects of Habits of Posture upon Health," by Dr. J. E. Goldthwait.

January 25. "The Tumors and Diseases of the Breast." (To women only.) By Dr. R. B. Greenough.

February 1. "Some Surgical Diseases of Childhood and their Causes," by Dr. J. S. Stone.

February 8. "Adenoids and Tonsils," by Dr. A. Coolidge, Jr.

February 15. "Microscopical Mechanisms of the Brain," by Dr. Charles S. Minot.

February 22. "Some Causes of Nervous Instability," by Dr. E. W. Taylor.

March 1. "Tooth Preservation in Children and Adults," by Dr. William P. Cooke.

March 8. "Skin Nostrums," by Dr. Charles J. White.

March 15. "Chairs, Backache and Curved Spine," by Dr. E. H. Bradford.

March 22. "Spectacles and Eye-glasses; their Use and Abuse," by Dr. Charles H. Williams.

March 29. "Diet in Relation to Diseases of the Kidney," by Dr. E. P. Joslin.

April 5. "Aid for the Deaf," by Dr. Clarence J. Blake.

April 12. "Eugenics *versus* Cacogenics," by Dr. E. E. Southard.

April 19. "The Hygiene of Pregnancy." (To women only.) By Dr. F. S. Newell.

April 26. "The Diagnosis and Immediate Treatment of Lesser Injuries, including the Use and Abuse of Antiseptics," by Dr. J. Bapst Blake.

May 3. "Arterio Sclerosis," by Dr. W. H. Smith.

May 10. "The Sexual Instinct; its Use and Abuse." (To men only.) By Dr. E. H. Nichols.

The following are the principal prizes, as we learn from the *British Medical Journal*, awarded by the Paris Academy of Medicine this year. The Louis Boggio prize (triennial, of the value of £172) has been given to M. H. Vallée, director of the Veterinary School of Alfort, for his researches on the prevention and cure of tuberculosis. The Adrien Buisson prize (triennial, of the value of £420), for the discovery of means of cure of diseases considered incurable, has been awarded to Dr. Dopter, professor in the École d'Application of the military health service, for his work on epidemic cerebro-spinal meningitis, the meningococcus, antimeningococcic serum, parameningococci, and antiparameningococcic serum. The Chevillon prize (£60), for the best work on the treatment of cancer, has been awarded to Dr. R. Robinson, of Paris, for his account of a method of biochemical diagnosis of cancerous affections. The Herpin (of Geneva) prize, for the best work on epilepsy and nervous diseases, has been awarded to Dr. André Barbé, of Paris, for his study of secondary (bulbo-protuberantial and medullary) disease of the pyramidal bundle. The Laborie prize (£200), for the greatest progress in surgery, has been given to Dr. Guisez, of Paris, for his work on brancho-esophagoscopy. The Meynot prize (£104), for the best work on diseases of the eye, has been awarded to Dr. F. Bourdier, of Paris, for his essay on the optic meninges and primary optic meningitis. The Roger prize (quinquennial, of the value of £100), for the best work on diseases of children, has been given to Professor E. Weill, of Lyons, for his book, "Précis de médecine infantile." The Tarnier prize (£120), for the best work on gynecology, has been awarded to Drs. P. Puech, of Montpellier, and J. Vanverts, of Lille, for their book, "Tumors of the Ovary and Pregnancy." The Tremblay prize (quinquennial, of the value of £284), for the best work on urinary diseases, has been awarded to Dr. E. Papin, of Paris, for an essay on the sexual functions and prostatectomy. Among the principal prizes of the Académie des Sciences are the Montyon prize in medicine and surgery; three, each of the value of £100, have been awarded to Madame Lina Negri Luzani, of Paris, for studies on the corpuscles, which, in conjunction with her late husband, she discovered in the nervous system of mad dogs; to Dr. L. Ambard, of Paris, for his

memoir on the renal secretion; and to M. A. Railliet, G. Moussu, and M. A. Henry, for their researches on the etiology, prophylaxis, and treatment of the distomiasis of ruminants. The Bréant prize has been divided as follows: Three prizes, of the value of £80 each, have been awarded to Dr. C. Levaditi, of Paris, for his researches on acute epidemic poliomyelitis and acute infectious pemphigus; to Drs. A. Netter and R. Debré, of Paris, for an essay on cerebro-spinal meningitis; and to Professor V. Babès, of Bucharest, for his treatise on rabies.

THE production of pig iron in 1912 was 33,802,685 tons of 2,000 pounds each; that of platinum was 1.3 tons. The value of the iron per ton was $12.44, as against $1,328,391 per ton for the platinum. For the sake of convenient comparison and because in commercial practise the various ores and metals are measured by a variety of units such as the long, short and metric ton, flask, avoirdupois pound and troy ounce, the United States Geological Survey has issued a short summary of the "Production of Metals and Metallic Ores in 1911 and 1912," stated in terms of the short ton of 2,000 pounds, much of which, however, is derived from imported ores, bullion, etc. A comparison of the production of some of the better known metals is as follows:

	Quantity	Value
Platinum	1.304	$ 1,732,221
Gold	188.108	113,415,510
Silver	4,471.4	80,187,317
Aluminum	32,803	15,089,380
Quicksilver	939.9	1,057,180
Nickel	22,421	17,936,800
Tin	8.4	8,850
Copper	734,052	242,337,160

THOUGH at one time in the early history of the country an average of 6,000 maple trees were destroyed in clearing the ordinary New York or Pennsylvania farm, maple is to-day, according to the department of agriculture, one of the most widely used and valuable native hardwoods. A bulletin on the uses of maple, just issued by the department, states that the wood finds place in an enormous number of articles in daily use, from rolling pins to pianos and organs. It is one of the best woods for flooring, and is always a favorite material for the floors of roller skating rinks and bowling alleys. It leads all other woods as a material for shoe lasts, the demand for which in Massachusetts alone exceeds 13 million board feet annually. Sugar maple stands near the top of the list of furniture woods in this country. The so-called "bird's-eye" effect, the department explains, is probably due to buds which for some reason can not force their way through the bark, but which remain just beneath it year after year. The young wood is disturbed each succeeding season by the presence of the bud and grows around it in fantastic forms which are exposed when the saw cuts through the abnormal growth. Maple, the department goes on to say, is one of the chief woods used for agricultural implements and farm machinery, being so employed because of its strength and hardness. All kinds of wooden ware are made of maple, which holds important rank also in the manufacture of shuttles, spools and bobbins. It competes with black gum for first place in the manufacture of rollers of many kinds, from those employed in house moving to the less massive ones used on lawn-mowers. Athletic goods, school supplies, brush backs, pulleys, type cases and crutches are a few of the other articles for which maple is in demand. Seven species of maple grow in the United States, of which sugar maple, sometimes called hard maple, is the most important. The total cut of maple in the United States annually amounts to about 1,150,000,000 feet. Nearly one half is produced by Michigan, with Wisconsin, Pennsylvania, New York and West Virginia following in the order named. Sugar maple, says the department, is in little danger of disappearing from the American forests, for it is a strong, vigorous, aggressive tree, and though not a fast grower, is able to hold its own. In Michigan it is not unusual for maple to take possession of land from which pine or hardwoods have been cut clean, and from New England westward through the Lake States and southward to the Ohio and Potomac rivers few other species are oftener seen in woodlots.

On the eastern edge of the campus of the Ohio State University rises a new building of white stone, the new museum of the Ohio State Archeological and Historical Society, which is to house the Indian relics and treasures of the mound builders which make Ohio the richest field of pre-historic remains in the United States. With the first week of the New Year the collections will be moved from their old home in Page Hall to their beautiful new building. The structure itself is as nearly fireproof as man can make it, utilizing stone, steel and concrete, with no wood used in its construction. Almost all the furniture is made of steel and the entire library and offices are similarly built. The exhibition rooms are entirely of mahogany as steel cases are impracticable. It is planned to have a formal opening in January, with appropriate exercises and public inspection of the rare collections housed in the building, appropriations for which were authorized at a recent session of the Legislature. Professor G. Frederick Wright, of Oberlin, is president of the society and Professor W. C. Mills, of Columbus, its curator.

At the recent meeting of the American Ornithologists' Union in New York City, as we learn from *The Auk*, the advisability of changing the time of meetings from fall to spring was considered. This innovation was favored for two principal reasons: First, to make it possible for those members to attend who, for business or other reasons, were unable to leave home in the autumn. Second, members residing on the Pacific Coast are very anxious that the stated meeting in 1915 be held in San Francisco while the World's Panama-Pacific Exposition is in progress. It was the consensus of opinion that spring was the most favorable time to hold this meeting and to successfully carry out the plan, it was thought advisable to allow at least a year to intervene between the Washington and San Francisco meetings. This would give members throughout the country ample time to plan in advance for the journey across the continent. In this connection it is to be remembered that the expense of the transcontinental trip will be greatly reduced if a considerable number of members and their friends attend. With the above plan in mind, the Committee of Arrangements has decided to name Easter week, beginning with April 6, 1914, as the best time for the Washington meeting.

UNIVERSITY AND EDUCATIONAL NEWS

The late Right Hon. G. W. Palmer bequeathed £10,000 to University College, Reading, and it is now announced that Mr. Alfred Palmer has suggested that this legacy should be devoted to building a university library, and on behalf of Mrs. G. W. Palmer, his sisters, and himself, has offered to supplement it to such extent as will be necessary to enable a suitable library to be built on the site reserved for the purpose, and also to provide an endowment fund for maintenance.

Gold Hall, a dormitory of the group of original buildings at the Connecticut Agricultural College, was burned to the ground on January 4, with a loss of $10,000.

The Stevens Institute of Technology announces that, beginning with the year 1914, admission to its freshman class will be either by certificate or examination. Students will be admitted to the freshman class on certificates from secondary schools which have been placed upon the accepted list by the faculty.

The civil engineering department of the engineering college of the University of Illinois offers a two weeks' course, January 19–31, to aid the newly appointed county superintendents of highways in preparing for their duties. In this the university will be aided by the state highway commission, whose engineer will be one of the leading speakers. The work is in charge of Professor Ira O. Baker, head of the department of civil engineering. The ceramics department offers a course, January 12–24. It is open to all who are engaged in factory operations. The process of clay testing, preparation, molding, drying, burning and decorating are to be treated. The work will be under the direction of R. T. Stull, acting director of the department, and Professor A. V. Bleininger, ceramic chemist, Bu-

reau of Standards, Pittsburgh, Pa. The agricultural department offers this year, January 19–31, some new courses in forge work and carpentry. These courses will under the immediate charge of Director Benedict, of the mechanical engineering department.

AT the Massachusetts Institute of Technology Dr. H. O. Taylor has been appointed to be research associate in the research laboratory of electrical engineering, and Francis Byron Morton to be assistant in physics, in place of F. I. Hunt, resigned.

AT Vassar College Dr. Elizabeth B. Cowley, instructor in mathematics, has been made assistant professor of mathematics.

THE governors of the Imperial College of Science and Technology have constituted two new chairs of chemistry, and appointed two new professors—Dr. Jocelyn Field Thorpe, professor of organic chemistry, and Dr. James C. Philip, professor of physical chemistry.

DISCUSSION AND CORRESPONDENCE

ON THE IDENTITY OF VERRUGA AND CARRION'S FEVER

WE are indebted to Dr. Richard P. Strong, of the Harvard Medical School, for reopening the question of the unity or duality of Carrion's fever and eruptive verruga, so termed. Assisted by Dr. E. E. Tyzzer, he carried out an interesting series of experiments at the bacteriological laboratory of the Institute of Hygiene in Lima, from June to August, 1913, in cooperation with Dr. Júlio C. Gastiaburú, the director of that laboratory. Some of the details of the results obtained were presented to the Fifth Latin American Medical Congress in Lima by Dr. Gastiaburú on November 14, 1913, causing a great sensation in Peruvian medical circles. It is not too much to say that this announcement has fallen like a thunderbolt in Lima. The thorough probing of the problem which will undoubtedly follow swiftly upon this reopening of the case will certainly bring the truth to the surface and settle the matter with finality. From the entomological and protozoological points of view, as well as from such clinical and other points of view as present themselves to the writer, the following data seem to bear definitely upon this subject.

Reasons why Carrion's fever and eruptive verruga (so-called) are respectively malignant and benign forms of one disease:

1. They have identically the same geographical distribution so far as known.

2. They are connected by every possible gradation of clinical symptoms.

3. The bone pains which are characteristic of the benign form often occur with marked severity associated with such high temperatures that the case must be diagnosed as malignant or Carrion's fever rather than benign or eruptive verruga (so-called).

4. Carrion's fever is always followed by the eruption, usually of the miliar but sometimes of the nodular type, the latter being more distinctive of the benign form of the disease, this indicating the identity of the malignant and benign forms etiologically.

5. Infection by *Phlebotomus verrucarum* from the same locality produces both in both man and laboratory animals, sometimes giving rise to one and sometimes to the other, apparently according to the severity of the infection due to the number of the infective *Phlebotomus* concerned or to the degree of resistance of the host infected.

6. The bodies named *Bartonia bacilliforme* by Strong and Gastiaburú are present in both, their abundance being apparently in direct ratio to the degree of fever exhibited at any time in any given case of either, and they disappear from the peripheral circulation of both immediately before the appearance of the eruption, though they may return if the course of the eruption be interrupted by pyrexial relapse, disappearing finally on the definite and uninterrupted sequence of the eruption.

7. The bodies *Bartonia bacilliforme* are quite evidently not organisms, but changes wrought in the red cells by the activities of the as yet undiscovered verruga organism, these changes evidently being effected in the bone marrow, as evidenced by the fact that the more abundant the *Bartonia* bodies are the

more abundant are normoblasts, megaloblasts and other abnormal red cells in the peripheral circulation.

8. Neither Carrion's fever nor verruga eruption can be produced in either man or laboratory animals by the injection of blood containing the *Bartonia* bodies alone, but both can be produced in man by injection of the virus from the human eruption, and the benign form can be produced in laboratory animals by such injection, the reason why the acute form has not been similarly produced being that either the animals are far less susceptible to the disease than man or the toxicity of the virus becomes attenuated for them after running its course in man, though experience indicates that it may yet be so produced in monkeys if not in other animals.

9. The pathologic microorganisms transmitted by *Phlebotomus* in all parts of the world so far as known invariably set up an initial fever stage of longer or shorter duration and greater or less intensity, and verruga eruption is in every case preceded by some degree of pyrexia, though sometimes so slight as to be hardly noticeable.

10. The eruption following Carrion's fever as well as the eruption preceded by mild fever or an almost unappreciable degree of fever both show a marked tendency to appear first at the sites of inoculation by the *Phlebotomus* and to become most pronounced at such sites.

11. Cases of eruption following either often if not always confer immunity against both.

12. *Phlebotomus verrucarum* gets its infection certainly from some reservoir, probably one of the native mammals, but whether from the lower mammals or man it is practically certain that the reservoir of infection supplies but one kind of microbe capable of developing in and being transmitted by the carrier.

13. Both are amenable to the same treatment so far as this has been determined for either.

All of the above facts have been verified by the writer's work and experience during his investigation of verruga transmission in the verruga zones and in the laboratory. Severe pyrexia has resulted in a *Cebus capuchinus* from the bites of the *Phlebotomus*, the rectal temperature passing 43° C. and the red cells showing the *Bartonia* bodies. Miliar eruption succeeded. The *Bartonia* bodies have also been found by the writer in the red cells of dog, rabbit and guinea-pig inoculated with the *Phlebotomus*. Eruption away from site of inoculation has been produced in a hairless dog by hypodermic injection of over 400 *Phlebotomus* in five lots, mashed up in physiological solution. Upon the excision of a large nodule, another has grown in its place. The writer's assistant in the verruga work, Mr. George E. Nicholson, is in the hospital with verruga, the result of 55 bites by *Phlebotomus* September 17 last at Verrugas Canyon, due to inadvertently getting his hands in contact with the net while asleep. His symptoms have been high fever with severe bone pains, and a large number of *Bartonia* bodies in the red cells. Details of the experiments with laboratory animals will shortly be presented, including blood and tissue studies, temperatures and weights, with illustrations.

Almost any one of the above reasons, taken by itself, would seem to indicate conclusively the unity of verruga. If Dr. Strong's thesis can be made to harmonize with all of these facts, then it is possible that he is right, but the indications seem to point strongly the other way. CHARLES H. T. TOWNSEND

VERRUGA LABORATORY,
CHOSICA, PERU,
November 17, 1913

SCIENTIFIC BOOKS

Scott's Last Expedition. Vol. I., being the Journals of CAPTAIN R. F. SCOTT, R.N., C.V.O. Vol. II., being the Reports of the Journeys and the Scientific Work undertaken by DR. E. A. WILSON and the surviving members of the Expedition. Arranged by LEONARD HUXLEY, with a preface by SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S. With 18 colored plates, 260 full-page and smaller illustrations. New York. Dodd, Mead and Company, 1913. Large 8vo. 2 vols. xxiv + 443, xiv + 376 pp. 8 maps. $10.00 net.

It is many years, if ever, since the civilized world has been so stirred into homage to courage and to sympathy for disaster, as were displayed when the ocean cables spread over the globe the fateful story of Scott's Last Expedition, which is now told in these beautiful volumes. Suffice it to say that the detailed record shows high planes of project and of action, which should ensure to Commander Evans and his surviving associates scarcely less honor and credit than is given so fittingly to Scott and his heroic dead.

That recognized polar authority, Sir Clements R. Markham, outlines the aims and scope of Scott's expedition as the "completion and extension of his former discoveries," especially of "fossils, which would throw light on the former history of the great mountains," which bound the south-polar plateau. For this work Scott had "the most completely equipped expedition for scientific purposes connected with the polar regions, both as regards men and material," and "a fuller complement of geologists, biologists, physicists and surveyors than ever before composed the staff of a polar expedition." Science was the primary aim, so that Scott had removed the taint of commercialism, which caused Milton to qualify his praise of the quest of a northern route to China by saying it "might have seemed almost heroic if any higher end than excessive love of gain and traffic had animated the design." Thus a twentieth-century sailor attained the seventeenth century ideal of heroism.

Referring briefly to the south-polar journey, it is clear that Scott's plans were perfected and carried out with striking ability. Despite a season of unprecedented severity as to blizzards and cold, the party would have survived but for other misfortunes. These were the inability to originally occupy Cape Crozier as a base, owing to ice-conditions; the breakdown and loss of motor sledges; and especially the deep, soft snow that fell during the four-day blizzard at Beardmore glacier on the outward journey. Later came the death of Evans from crevasse-injuries and sastrugi-falls, and the freezing of heroic Oates, which followed close on the time lost and delays caused by geological work, a primary aim be it remembered. Let the readers of SCIENCE bear in mind that these men perished indirectly as martyrs to a sense of scientific duty. The day spent in collecting the fossil volumes that may tell the story of past geological history, and the strength consumed in dragging these specimens, nearly forty pounds in weight, exhausted the fatal limit of time and so sealed their fate. Yet no word is uttered suggestive of abandoning their harrowing load, over frightful mazes of sastrugi and of glacier.

This is not the place to dwell on the ideals of courage, of devotion, of unselfishness, which ran like the King's red thread through the warp and woof of their expeditionary duties—of the living as well of the dead. Their recital moves the hearts of the present, and will serve as examplars to stir the souls of the future.

Storm-bound and crevasse-injured, the southern party perished to a man within eleven miles of safety, while ending a sledge journey of more than sixteen hundred miles,—unprecedented for its length in polar annals. As to conditions which prevented that short march to food and fuel, they had for the ten previous days traveled in temperatures averaging sixty-eight degrees below freezing (this in March, *our September*), and were enveloped in a blinding blizzard, which lasted continuously for eight days.

In these transcripts from Scott's diary are no words of adverse criticism when he received the astounding news that a rival was in the field,—for south-polar travel only be it noted. Amundsen's route being shorter, foreseeing the probability of being forestalled at the pole, Scott recalls with becoming dignity of soul the scientific scope of his work in the sober statement, on September 10, 1911, that "nothing, not even the priority at the Pole, can prevent the expedition ranking as one of the most important that ever entered the polar regions."

Severe as were the physical experiences of the south-polar party in their dramatic explorations, they entailed relatively less bodily discomfort and acute suffering than did the midwinter journey for strictly scientific pur-

poses to the penguin rookery at Cape Crozier. The object of the trip was to secure eggs of the emperor penguin—a species most nearly approaching the primitive form of bird—at such stages of early embryos as might make clear the development of the emperors. A journey in midwinter was necessary as the singular emperor penguin is perhaps unique in nesting at the coldest season of the year—in temperatures approximating one hundred degrees below the freezing point of water.

Apart from the weather the trip involved sledge travel of two hundred miles in almost complete darkness, wherein the party must cross the crevassed "barrier" and finally pass through the chaotic pressure-ridges of the shore-impinging sea floes. The journey was made without disaster, and three eggs brought safely home, but this scientific work tested humanity to the utmost. The outward march was made in eighteen days with an average temperature of minus forty degrees—that of frozen mercury. Only once did the temperature rise to zero Fahr., and a minimum of one hundred and nine degrees below freezing was experienced. A violent blizzard, in which an hourly wind velocity of 84 miles was recorded at the home station, blew away their tent and unroofed their hut. Exposed to the fury of the storm they were forty-eight hours without food, uncertain of their fate. They finally recovered their tent, without which they must have perished, for the blizzard temperature of $+24°$ fell steadily to $-66°$ Fahr. For science and not for fame was made a trip unsurpassed as to the severity of cold and violence of storm successfully endured by a field party.

The scientific appendices to these volumes are brief and tentative, as would naturally be expected. Full of thrilling interest and of importance are the accounts of the journeys made for the physiographic and geological explorations of the coast regions of northeastern South Victoria Land. The enforced wintering of Campbell's party, equipped for summer travel only, was on the verge of disaster several times. Wintering in a hut carved out of a snow-covered glacier, they lived for nine months from hand to mouth on penguins and seals. Other scientists had experiences but little less dangerous and trying. Indeed it may be said that no previous polar expedition has ever surpassed that of Scott in the devotion of its staff to scientific investigations entailing personal, prolonged and perilous service.

Brief chapters treat of scientific work, such as that wonderful survival of the condition of the Ice Age—the so-called barrier of Ross; the physiography and glacial geology of South Victoria, supplemented by a geological history of that ice-clad region; fossils connected with coal-beds, and those thought to be suited to settle the controversy as to the nature of the connection of Australia and Antarctica; and as to ice physics. Meteorology, tides, magnetism, pendulum work, and atmospheric electricity are treated, though incompletely, while the local sea-work is supplemented by a summary of the biological investigations carried on by the *Terra Nova* in her voyages from 1910 to 1913. Volcanic investigations were pursued on Mt. Erebus, and fossil evidences were obtained from the Great Beacon Sandstone Series.

No previous volumes of polar narrative have been so fully and appropriately illustrated as this thrilling story of the work of Scott's Last Expedition, largely due to Dr. Wilson and Mr. Pointing. Not only do the illustrations please the artistic sense, but many will also be of permanent value to scientific students. This is especially true of the photographic plates showing glacial conditions, and the many beautiful reproductions of snow and ice forms. Nor can one neglect those of birds and seals, of mountains and clouds, and even of blizzards. Among the 278 full-page plates will be found some which will convey ampler and clearer ideas to experts than does the written word.

The editorial supervision must have been hasty, for there are many slips and the text is overburdened—detracting from the dignity of the narrative. The main map is most unsatisfactory. Oates Land does not appear thereon. It is an offence to Americans that not only is Wilkes Land omitted from the key map, but it

has been replaced by King George V. Land; patriotic but a sad blunder.

The appreciation accorded to the Scott expedition excites reflections as to the contrasting attitude of the United States and of European governments towards scientific work that is neither commercialized nor exploited. Strikingly similar in aims, in accomplishment and in fateful disaster were the Lady Franklin Bay International Polar Expedition and Scott's Last Expedition. The former—a governmental enterprise—penuriously fitted, its scientific work largely entrusted to enlisted men—who were actuated largely by love of science—occupied the post of honor and of danger of the eleven cooperating nations. It contributed to a hitherto unequalled degree to arctic hydrography, meteorology, pendulum work and magnetism. Yet its complete success in its scientific purposes, as well as in field-work absolutely free from disaster, was formally requited neither by the government nor by any scientific societies of the United States. It took years of effort on the part of its chief to even obtain the meager lawful allowances and the pitiful pensions.

The English expedition, lavishly equipped, had 7 officers and 12 scientists, whose efforts also increase to a very large degree our scientific knowledge of Antarctica. Its heroic personnel win titles of nobility, promotions and the highest scientific honors, while the public contributed hundreds of thousands of dollars to meet adequately and generously all expeditionary requirements—both material and memorial.

The failure of our government to properly recognize scientific work appears to be due to an antiquated and inherited national policy, which must be to the ultimate detriment of the common weal. This year the attention of the government has been urgently called to untoward conditions, arising from illiberal treatment of expert officials. Distinguished chiefs of several important national bureaus officially report increasing difficulty in maintaining an efficient scientific staff. Unusual and steadily augmenting numbers of scientists and experts are accepting commercial positions in order to meet the enhanced cost of living.

While American admiration for the Scott expedition was so great that we materially aided in the raising of the memorial fund, our energies should also be employed in urging the adequate recognition of those scientific and professional officials, on whose skill, judgment, and patriotism the future of the democratic government in the western hemisphere must so largely rest.

A. W. GREELY

Probleme der physiologischen und pathologischen Chemie. Fünfzig Vorlesungen über neuere Ergebnisse und Richtungslinien der Forschung für Studierende, Ärzte, Biologen und Chemiker. By DR. OTTO VON FÜRTH. II. Band: Stoffwechsellehre. Leipzig, Verlag von F. C. W. Vogel, 1913. Pp. xiv + 717.

The only occasion for adding anything to the favorable impression of Professor von Fürth's lectures which the reviewer has already expressed[1] in reference to the first volume lies in the fact that the newer collection deals with a more specific group of topics: metabolism. The author's underlying plan consists in starting with the nutrients at the very beginning of the alimentary processes and in following the foodstuffs, as far as present knowledge permits, on their travels through the organism to the places where the final derivatives disappear in the unexplored depths of intermediary metabolism. To this is added a discussion of the nature of those ultimate stages of this physiological function which are characterized by the combustion of the food fragments in the living organism. In pursuance of the foregoing scheme the chemistry and physiology of digestion and absorption are reviewed in the light of those newer contributions which take cognizance of the special conditions that pertain in the alimentary canal, with its unique innervation and secretory interrelations.

The attitude of the critic to a contribution like the present one—a book giving evidence on every page of the remarkable familiarity of

[1] See SCIENCE, 1912,

the author with the enormous modern literature of chemical physiology and his sympathy with a treatment of its problems less narrow than is current in many quarters—can not be determined by the same criteria that apply to text-books or laboratory manuals. Von Fürth's lectures make no pretense to systematic formulation of routine topics; they offer something far more stimulating to the advanced student, namely, viewpoints to guide him, and goals to be reached. The limitations of our present knowledge sre frankly pointed out. What could be more satisfying than this (freely translated) incidental confession of the author in presenting the subject of purine physiology:

"The sum total of the available observations is so vast that no honorable person, even if he devoted years of effort to this topic alone, could maintain that he had delved into the ultimate depths of the subject and fully mastered it. Yet how perverted it would be if I, who have not devoted myself permanently to this field, were simply to traverse it hastily, contenting myself with a few dogmatic statements. Bear in mind that I am merely attempting, in so fsr as my efforts permit me to appreciate it. to present to you a picture of this world of phenomena; and do not forget that this picture would appear different to other eyes. It is a human privilege to sec the things of the external world with our own eyes; but we must not deceive ourselves into forgetting that it is, after all, a subjective point of view that we take."

Here, as in the first volume, there are personal touches and subjective impressions that lend a sort of enlivening color to the treatment of topics that the usual writer is apt to present in a stereotyped fashion. A few quotations may serve to illustrate what is here meant. The reviewer can not conceal his satisfaction in reading the following:

"Man hat sich vielfach bemüht, die moderne Entfaltung der physikalischen Chemie auch dem Probleme der Salzsäurebildung im Magensafte dienstbar zu machen. Als seinerzeit die Ionenlehre langsam in die biologischen Disziplinen einzusickern begann, konnte man vielfach die Beobachtung machen, dass eine Übersetzung einer Fragestellung in die Sprache der Ionenlehre mit einer Erklärung verwechselt wurde. Heute ist man sich wohl ziemlich im Klaren darüber, dass, wenn ein Problem in noch so gelehrter Weise mit dem grösseren Publikum schwer verständlichen Fachausdrücken umschrieben wird, man seiner Erklärung nicht näher kommt, als wenn man dasselbe etwa in spanischer oder russischer Sprache formuliert. Leider ist hie und da ein Restchen der Bemühungen mittelalterlicher Magister, durch möglichste Schwerverständlichkeit ihrer hochgelehrten Darstellungen ihrem Auditorium nur so recht zu imponieren, auch noch in der modernen Wissenschaft (insbesondere in der medizinischen) zu verspüren" (p. 10).

The author's sttitude toward many open questions is expressed in the concluding sentence of a discussion of the purpose of the complete digestion of proteins to amino acids.

"Dass aber ein Individuum, trotzden es die allerverschiedensten Proteinsubstanzen mit seiner Nahrung aufnimmt, stets und unter allen Umständen und sein ganzes Leben lang die Spezifizität seiner körpereigenen Eiweisskörper in allerstrengster Weise zu wahren vermag, kann ich nur so verstehen und begreifen, dass ich mir vorstelle, jeder Eiweisskörper der Nahrung werde vor der Assimilation sehr wahrscheinlich bis zu den Aminosäuren desintegriert. Doch ist das eine durchaus subjektive Meinung, die ich Sie nur als solche hinzunehmen bitte. Schliesslich kann ja jeder Mensch nur mit seinem eigenen Kopfe denken" (p. 73).

Similarly at the end of an excellent review of the theories of gout, in which he champions Wiechowski's views, von Fürth remarks:

"Es ist mir wohl beksnnt, dass andere diese Dinge anders beurteilen;—aber, wie ich schon früher einmal sagte: jeder Mensch kann nur mit seinen eigenen Augen sehen und mit seinem eigenen Kopfe denken. Glücklicherweise kommt jedes naturwissenschaftliche Problem früher oder später in ein Stadium, wo allen subjektiven Auffassungen ein natürliches Ende gesetzt ist und der objektive Sachverhalt

als etwas Selbstverständliches erscheint" (p. 171).

The welcome touches of humor creep in here and there, as in the following conclusion:

"Dagegen ist die Frage der Herkunft endo- und exogener Harnpurine, nachdem allerdings ganze Ströme von Tinte für sie geflossen sind, immerhin so weit gediehen, dass sie (—und das ist immer ein gutes Zeichen—) eigentlich mit wenigen Worten erledigt werden kann" (p. 150).

Again:

"Es macht nun den Eindruck, dass dieses (bisher wenig beachtete) Moment einer beim Gichtiker gesteigerten Affinität der Gewebe der Harnsäure gegenüber dem Kerne des Gichtproblems näher steht, als z. B. die Frage der Harnsäurebindung im Blute, welche so viel Staub aufgewirbelt hat, und mit der wir uns jetzt auch notgedrungen ein wenig beschäftigen müssen" (p. 175).

And in advising a liberal intake of water in gout the author recognizes that he is merely repeating the dicta of empirical practise. Hence he reflects:

"Es wäre hier, wie überall, durchaus unangebracht und verkehrt, wenn wir das, was nüchterne und objektive Beobachter mit ehrlichem Bemühen bei jahrzehntelanger Beobachtung für zweckmässig befunden haben, einfach ignorieren wollten, weil wir dafür keine theoretische Erklärung zu finden wissen. Vergessen wir nie, dass die Beobachtungen richtig und die Theorien falsch sein können und dass ein richtiger Naturforscher die ersteren im allgemeinen höher bewertet als die letzteren. Nur ist das objektive Beobachten insbesondere bei der Therapie chronischer innerer Erkrankungen leider eine unendlich schwierige Sache, daher dieselbe zu allen Zeiten und bei allen Völkern das gelobte Land der wissentlichen und unwissentlichen Charlatanerie war und sein wird" (p. 190).

The admonition to caution, on the other hand, in rejecting the suggestions of science is brought out in a discussion of Friedenthal's proposal to render the common vegetables more readily available in the nutrition of man. Von Fürth writes:

"Der Wunsch, Menschen zu Gras- und Blätterfressern zu machen, mag Ihnen vielleicht auf den ersten Blick recht lächerlich erscheinen. Vergessen Sie aber nicht, dass es nicht immer die schlechtesten Errungenschaften des Menschengeschlechtes waren, (—ich erinnere Sie an die Dampfmaschine, das Leuchtgas und die Elektrizität—), welche in ihren ersten Anfängen von der Mehrzahl der Zeitgenossen nur von der humoristischen Seite aufgefasst worden sind. Vielleicht stehen wir hier vor einer jener Möglichkeiten, das Dasein späterer Generationen leichter zu gestalten, als es den jetzt Lebenden zuteil geworden ist" (pp. 480–481).

It is of little value to refer here to the details of a book so replete with up-to-date information and so readable at the same time. A typical specimen of the care and comprehensiveness with which the facts have been collected and reviewed is furnished by the discussion of the rôle of muscle in glycolysis. The entire story is told from the early work of Cohnheim, through the critique of Embden and his coworkers, to the latest constructive criticism of Levene and Meyer. An example of the intelligent reconciliation of conflicting views is exhibited in the discussion of the origin of endogenous urinary purines:

"Wir werden uns daher bemühen, uns von jeder einseitigen Auffassung fernzuhalten und weder die Leukozyten, noch die Muskeln, noch die Tätigkeit der Verdauungsdrüsen oder Nieren für die endogene Harnsäurebildung ausschliesslich verantwortlich machen, dieselbe vielmehr als den Ausdruck einer jederzeit und in allen Geweben sich vollziehenden Zellabnützung betrachten" (p. 151).

Von Fürth is at his best in the discussion of the special features of alimentation and the intermediary metabolic phenomena. His treatment of the problems and methods of general metabolism—the balance of matter and energy —is far less detailed, yet always timely. The unbiased attitude is nowhere better shown than in the comments on the status of the much debated questions of the protein minimum in human nutrition and the theories of protein metabolism:

"Es sind dies eben Dinge, die sich wirklich gegenwärtig nicht, ohne gegen das Postulat der Objektivität zu sündigen, mit wenigen Worten abtun lassen. Ein Blick auf Casparis Literaturverzeichnis, das mehr als ein halbes Tausend Abhandlungen umfasst, wird Ihnen zeigen, dass ich darin recht tue" (pp. 475–476).

In conclusion the reviewer is tempted further to quote the judgment of von Fürth respecting the duty of an investigator to correlate his own experiences so that they afford a logical summary of his undertaking. Thus in referring to the myriad of details published in recent years by London and his pupils on the physiology and chemistry of the digestive functions von Fürth remarks:

"Ich bin ehrlich genug, um offen einzugestehen, dass ich mich einer Würdigung dieser ungeheuren Fülle von sicherlich sehr verdienstvollen Einzelbeobachtungen nicht gewachsen fühle. Eine solche wird wohl erst dann möglich sein, wenn London selbst sich einmal der Mühe unterzieht, dieselben im Zusammenhange kritisch zu verarbeiten und seine leitenden Gedanken, die auf so viele Publikationen verteilt sind, dass der Aussenstehende den Zusammenhang verlieren muss, hervorzuheben. Es ist dann zu hoffen, dass sich aus diesen und anderen Arbeiten, welche verwandten Zielen zustreben allmählich ein abgerundetes Bild des Eiweissabbaues im Darme in seinen einzelnen Phasen gestalten wird" (p. 71).

To those who wish to orient themselves in the changing aspects of physiological research, particularly its chemical manifestations, the lectures by von Fürth will surely serve as a stimulating guide. Books of this type are rare.

LAFAYETTE B. MENDEL
SHEFFIELD SCIENTIFIC SCHOOL,
NEW HAVEN, CONNECTICUT

Alternating Currents and Alternating Current Machinery. By D. C. and J. P. JACKSON. New York, The Macmillan Company, 1913. Pp. viii + 968, 521 text figures. Price, $5.50.

This new edition of a well-known work furnishes one of the best general treatments on the subject of alternating currents, as did the first edition in 1896. Rewritten and expanded to twice its former size, it forms a very complete and, on the whole, well-balanced treatise. The work is attractive, the style easy and the illustrations, many of them diagrammatic, are instructive. Descriptive and mathematical discussions are combined throughout, and examples from practise are used to illustrate theory.

Attempting to cover so much in a single volume assigns a formidable task to both author and reader. Although on the whole satisfactory, the treatment might to advantage have been made more systematic; the book would not have suffered by being more condensed. The chapters on synchronous machines (185 pages) and on transformers (155 pages) approach special treatises on these subjects. The latter would be improved by complete rearrangement, the discussion of mutual induction forming not so suitable an introduction to the transformer, in a book of this kind, as would a discussion of diagrams and equivalent transformer circuits that are discussed later in the chapter. The discussion of power and power factor is particularly satisfactory and complete.

That the authors omitted many historical footnotes seems unfortunate. Such notes not only serve to give credit where it may be due, but they make possible for the reader a more detailed study of special subjects than the limited description of any one text will permit. The footnotes retained (and these are not a few) prove their value. The authors refer in their preface to the intentional omission of many notes on the ground that they are unessential for undergraduates. But the scope of the book justifies no such limitation; its field is much wider than the undergraduate class-room. The book should find many readers whose undergraduate days have long since passed. The authors are to be thanked for its production.

FREDERICK BEDELL
CORNELL UNIVERSITY

Petrographisches Vademekum. Second edition. By E. WEINSCHENK. Freiburg im Breisgau and Saint Louis, Mo., Herder Pub-

lishing Company. 1913. Pp. viii + 210; 1 plate; 101 figures in text. Price, ninety cents.

This little volume presents in an interesting manner those facts concerning rocks which are of interest to the student of general geology. The author has in mind a pocket manual which may be of service in the field. The treatment is from the standpoint of the macroscopic properties of rocks and is thoroughly modern. The book is well printed. The illustrations are excellent.

EDWARD H. KRAUS
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UNIVERSITY OF MICHIGAN

SPECIAL ARTICLES

THE CULTIVATION OF TISSUES FROM THE FROG

IN a series of experiments on the culture *in vitro* of tissues of the frog it was found that several kinds of tissues show a marked outgrowth after being kept for a few days in lymph or plasma. Small pieces of the tissues were mounted according to the usual method in hanging drops of the culture medium and sealed with vaseline in hollow slides. Cells may remain alive under these conditions for several weeks.

Spleen, bone-marrow and pseudothyroid give rise to a fringe of outwandering cells resembling leucocytes which extend farther and farther into the surrounding medium. Larger connective tissue cells wander out later, and both types of cells exhibit amœboid changes. Small pieces of tissue may almost entirely disintegrate into wandering cells.

The epithelial cells of the skin extend generally as a broad thin sheet of tissue. The cells move out in contact with the cover slip or the lower surface of the drop. Individual cells of the epidermis may become isolated and creep out alone, but there is a marked tendency for the cells to keep together in a continuous membrane. In a previous paper on the movements of the ectodermic epithelium of amphibian larvæ[1] it was shown that the ectoderm cells actively creep out by an amœboid movement of the very thin and transparent protoplasm of their free borders. The method by which sheets of epithelium extend in the adult frog is essentially the same as in the embryo or larva.

In several cases black pigment cells were seen to isolate themselves and wander out along the cover slip or lower surface film of the drop. In some cases, especially in the smaller pigment cells, the changes in form were fairly rapid. Pseudopods were thrust out and retracted very much as in the common amœba, and in some instances the cells were seen to migrate nearly across the field of the microscope. The processes of the pigment cells of the adult, unlike those of the larvæ, may be nearly transparent, and they usually are so when first formed; frequently, however, they are very soon invaded by pigment granules. Outwandering cells may show branching processes characteristic of the expanded melanophores of the frog's skin. The change in form of the pigmented mass within the cell is due in part to changes in the outline of the whole cell and in part to the flowing back and forth of pigment granules within the cell processes. There is a measure of truth, therefore, in both the rival theories of the changes of the chromatophores in the skin of the frog.

In some preparations the peritoneal epithelium wandered out in the form of a sheet of tissue considerably greater in area than the original preparation. For the most part the extension consisted of flattened cells arranged in a single layer and showing a hexagonal contour like the cells of the shed cuticle. Many of these cells were furnished with cilia which beat actively for two weeks. The ciliated cells frequently became amœboid and wandered free from the rest, sending out fine processes several times the original diameter of the cell. Sometimes the processes branched repeatedly. One would not suspect these cells to be derived from ciliated epithelium were it not for their tuft of beating cilia, and the fact that one can actually observe their transformations. Follicle cells of the testis may creep out and give the appearance of giant amœbæ.

Fuller details of the behavior of various

[1] Univ. of Calif. Pubs. Zool., 1913.

types of tissue cells will appear in later papers. Similar experiments were tried with the tissues of crayfishes and crabs with little result beyond keeping these cells alive for several weeks. The blood corpuscles of the crayfish were kept alive and active for three months.

S. J. Holmes

NOTE ON THE ABSORPTION OF CALCIUM DURING THE MOLTING OF THE BLUE CRAB, CALLINECTES SAPIDUS

The problem of molting in crabs has thus far been investigated, with one exception,[1] only from the morphological point of view.[2] The following observations bear on certain chemical phases of the process of hardening following normal molting in the common blue crab.

The crab hardens by the deposition of $CaCO_3$ within the tissues of the soft shell. Has this Ca been absorbed and held in reserve during the period of preparation for molting,[3] or is it absorbed from the sea-water during the actual period of hardening? To test this matter, the following procedure was employed. Three pairs of crabs were chosen, each pair consisting of a recently shed individual and of a hard-shell individual of nearly the same size.[4] A comparison of the Ca content of the individuals of the same pair should throw light on the alternatives suggested. If the Ca content of the two members of each pair is equal, then the Ca must be absorbed before molting and held in reserve. If the Ca content of the hard specimen is very much larger than that of the soft, then the Ca must be absorbed after molting. Furthermore, if the first alternative is the true one, the Ca content of a crab in the act of casting its shell should be much greater than that of a normal hard crab. If, however, they have the same Ca content, then the second alternative is indicated.

Each crab was ashed separately, and the Ca in the ash determined by precipitating it as the oxalate, igniting and weighing as the oxide. The results of the analyses are indicated in the table. In each pair the hard-shell specimen contains about twenty times the amount of Ca contained in the soft one. Also, Crab No. 9, which was in the act of casting its shell, has a Ca content comparable to that of a normal hard individual.

This shows clearly that the Ca used by the soft-shell crab for the purpose of hardening its new shell is not present at the time of the molt, but is absorbed from the sea-water during the hardening.

The mechanism by means of which a molting crab is enabled to absorb such abnormally large quantities of Ca is at present obscure, and in view of the meager data at hand, a discussion of this problem is best postponed until more work shall have been done.

TABLE

Crab No.	Condition	Width, Cm.	Weight, Gm.	Weight, Ca, Gm.	Ca Content, Per Cent.
6	soft	8.3	37.[illegible]0	0.0720	0.19
11	hard	8.3	34.54	1.845	5.34
3	soft	9.7	56.53	0.1468	0.26
7	hard	9.5	61.62	2.963	4.81
13	soft	10.5	70.00	0.2197	0.31
12	hard	11.0	70.90	3.617	5.17
8	hard	8.7	54.75	2.861	5.22
9	molting	8.5[5]	67.93	2.520	3.72

Selig Hecht

Biological Laboratories,
The College of the City of New York

[1] Irvine and Woodhead, *Proc. Roy. Soc. Edinb.*, Vol. 16, pp. 324–354, 1888–89.

[2] For a review of the literature on the natural history of molting in Crustacea, see Herrick, Bull. U. S. Bureau of Fisheries, Vol. XV., pp. 1–252, 1895. For this species of crab, see Hay, App. Rep. U. S. Comm. Fish., pp. 395–413, 1904.

[3] *Cf.* Smith, *Quart. Journ. Microsc. Sci.*, Vol. 59, p. 272, 1913.

[4] These were collected at the Beaufort, N. C., station of the U. S. Bureau of Fisheries. The writer is indebted to Dr. H. M. Smith, the commissioner, for the privilege of staying at the station.

[5] The width of the new shell was 9.8 cm. The *per cent.* of Ca in this specimen is low because the molting crab weighed more than an ordinary 8.5 cm. crab, and also because the old shell had two legs missing, which were being regenerated. The *actual* weight of Ca, however, is very close to that of a normal hard crab.

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE ninety-second regular meeting of the Botanical Society was held at the Powhatan Hotel on Tuesday evening, December 2, 1913, at which a dinner and special program were given in honor of the seventieth birthday of Dr. Edward Lee Greene, the president, Dr. C. L. Shear, presiding.

Mr. John H. Parker was elected to membership.

The program was as follows:

Personal Experiences: MR. FREDERICK V. COVILLE.

Mr. Coville related incidents in connection with his first meeting with Dr. Greene at the Madison Botanical Congress in 1893, and expressed a high appreciation of his work, particularly of his "Landmarks of Botanical History."

Berkeleyan Days: MR. V. K. CHESTNUT.

Mr. Chestnut spoke of his student days at the University of California and of the inspiration received from Dr. Greene by his botanical students.

Botanical Writings: PROFESSOR A. S. HITCHCOCK.

Professor Hitchcock recalled at the International Botanical Congress in 1893 at Madison an incident as illustrating Dr. Greene's taxonomic methods. One day he showed to a group of interested botanists a difference between the two common species of foxtail grass, *Chætochloa viridis* and *C. glauca*. He pointed out that the blades of the first were straight, while those of the second were twisted into a partial spiral. He stated that the reason why these differences were not given in the books was partly from tradition, it not being considered good form to depart very widely from the system of basing differences on the characters of the flowers or fruit; and partly for the reason that the botanists who wrote the books were not sufficiently familiar with the growing plants.

Dr. Greene's first taxonomic paper[1] was entitled "Notes on Certain Silkweeds."

Professor Hitchcock stated that the value of Dr. Greene's contributions to botany or his influence upon botanical thought did not rest solely upon the large number of new species he had described, but that he had studied many groups of plants, had revised many genera, discussed relationships and set on their feet, as it were, species and genera of early authors that had been relegated to oblivion by those that followed.

Reminiscences: MR. IVAR TIDESTROM.

Mr. Tidestrom stated that Dr. Greene began his botanical career before the Civil War. In 1862, while a young soldier of nineteen in the army of General Grant, he collected a number of plants from the battlefield of Fort Donelson. This collection he sent to his mother, who had them mounted in an album and exhibited at a fair of the Sanitary Commission at Chicago. The collection was sold for $50 and the money applied for the relief of sick and wounded soldiers.

Dr. Greene, after all the jealousies and personalities have disappeared, should be remembered not for the many species he has diagnosed, but for his unchallenged devotion to botany, for the gathering of an herbarium of nearly 100,000 specimens, and a library of some 3,600 volumes.

Mr. Tidestrom then stated that a few botanists knew the plants of their regions better than any one else, but challenged any one to produce a man who could approach Dr. Greene in the knowledge of plants of the vast empire lying between New York and San Francisco.

Rocky Mountain Flora: PROFESSOR AVEN NELSON.

"I count it singularly fortunate that this interesting event should have happened to occur during my short stay in Washington. I feel doubly delighted in that I am permitted not only to express my personal pleasure by my presence but also to voice for others, as well as myself, the high regard with which we greet the man whom to-night we delight to honor.

"The third part of a great continent, the interior west; the Rocky Mountain region of America, brings its greetings of good-will and love to him to whom its floral wealth is an open book. To every working botanist in this vast field the name of our guest is a familiar word. It matters not whether he be devoted to the technical or the applied phases of the subject at some point in his work every botanist finds the taxonomist's services required. I therefore presume to speak for my colleagues in every experiment station, college and university from Mexico to Manitoba and westward to the sea; and not for my colleagues only but for every amateur who loves the wayside flower for its own sake, as well as for that larger public that loves the woods and fields for their beauty and for their bountiful products. These all send greetings and grateful acknowledgment of the help and pleasure conferred upon them.

"For more than forty years Dr. Greene has loved the plants of the west with a love born of sympathetic, first-hand companionship. To the seemingly barren saline deserts, the chaparral-covered hills, the grassy parks, the dense forests and

[1] *Bot. Gaz.*, 5: 64, 1880.

the alpine heights he is no stranger. Could he leave his more serious tasks long enough he would hasten to greet the floral friends of that earlier day as well as to renew his fatherly interest in the hundreds of plant children of his maturer years. When Edward L. Greene first began tramping over the plains, racing through the valleys or eagerly climbing the unknown heights of Colorado and Wyoming your speaker was still a small boy on an Iowa brush farm. Little did I then think as, plowing corn with old Dobbin, I stopped to pick the cockle-burs from between the toes of my bare feet, that some day I too should be vitally interested in strange and beautiful plants in a, to me, unknown land. But to my friend and teacher (for such I count him in the largest and best sense) they had even then become of absorbing interest. He was gathering specimens in order that he might know the splendid treasures that greeted him at every turn.

"This man, a missionary, in rounding up and corraling for a life of decency and usefulness, the cowboys of the then 'wild and woolly' west, traveled far and wide. He sought men in the open marts and plants in their secluded nooks. The offerings he brought back to the altar were both acceptable, but may it not be that, reversing the order of that primal day, the flowers and fruits of the field yielded more acceptable incense than the firstlings of the flock? I imagine that as the years sped by, he more and more taught men of the wisdom and goodness of the Creator through the marvelous adaptations and beauty of the flora.

"As preaching is teaching and teaching is preaching, so the transition to the professor's chair was an easy one. During the years as they were slipping along, his field of observation widened, his knowledge of plants and their characters deepened, and his theory of the principles of classification ripened. Thus he has gradually been brought into the zenith of his power. Plants from the east and the west, from the north and the south have passed under his observation, but no field has received such discriminating scrutiny as the Rocky Mountains. He knows this field piecemeal; he knows it as a whole.

"And what a flora it is! Some of the states have singly almost as many species as the whole empire east of the Missouri. Environments of greatest diversity as to soil character, water content, heat and light factors, and all these interacting upon each other as they are successively modified by altitudes varying from near sea-level to alpine heights have given a flora that is marvelous in its complexity. Near relatives of species well fixed under normal and uniform conditions seem here to have been thrown into such a state of 'wobble' that new forms appear to have arisen over night. Multitudinous variations, more or less well fixed, crowd upon each other everywhere. Decry species-making as you will, in the west nature seems to have been working overtime at this very thing and in a very abandon of joy. Then why should not her greater children who have the eyes to see and the mind with which to discern read and record the results?

"In this work Dr. Greene holds and has long held an enviable place. The intimate field knowledge of the earlier decades of his career forms the basis for the discriminating work that is now the marvel and the despair of those of us who have drunk less deeply at the Pierian spring. As we note his facile pen, the classical clearness, brevity and exactness of his diction, the rapier-like thrusts of his criticism, that cut but carry no toxins, one can not help feeling that for a botanist to know little Latin and less Greek is a misfortune—nay almost a crime. Sometimes such an one must wonder whether

> 'Twere better to have loved and lost
> Than never to have loved at all.'

"For our crass ignorance he has scourged us again and again. Though the lash may 'cut to the quick' yet by these stripes are we being healed. They were never meant to drive a man from the field simply because he is a beginner. Dr. Greene always has a word of encouragement for him who enters Flora's temple to worship in the right spirit. He manifests no desire to preempt the place and the 'divine right' of the king is not engraved upon his banner.

"That other eyes fail to see the things that he sees; that even from similar observations different judgments are formed and different conclusions drawn are not to him of such serious moment that each may not go on with friendship for the other, each cultivating his own wee bit of the ever-widening field. To live honestly with nature, to deal justly with your fellow worker, to love mercy is a creed to which we can all subscribe. Were this not true and generally practised, few there be that would dare to follow nature in her devious paths. No single mind can grasp all her secrets. Truth is always truth but she is many-sided. No one pair of eyes can view her from all sides at any one time. A partial truth may in effect, there-

fore, be a complete error, hence error often rides in honesty's carriage.

"Differ as we may as to what constitutes a species, the object of us all is to know plants and to help others to know them. To know and to use plants that they may contribute to our wealth is well; to know them that they may contribute to the health and pleasure of body and mind is better; to know them that we may read a few of God's thoughts after him and thus enrich our souls is best. He who puts us in closer touch with the Creator through his creations is doing a man's work in God's world.

"In conclusion let me say that we have not met to place wreaths upon the brow of our distinguished coworker. There are none which his splendid achievements in systematic, historical and philosophical botany have not already won. His head is already resplendent with a silvery crown. The white is not the frost of many winters. It is the incarnation of the spirit of beauty and service that finds its best expression in spring-time flowers and autumnal fruitage. New radiance is gained at every passing milestone. May there still be many of them. May all the years bring seed-time and harvest in which the fruitage shall be as abundant as in the seven years typified by the seven well-favored, fat-fleshed kine that Pharaoh saw in his dream—fruitage even unto well-filled ears upon every stalk. May no lean kine nor blasted ears devour any of the beautiful years in the life of him who is seventy years young to-night."

Response: DR. GREENE.

Dr. Greene, after expressing his appreciation of the honor accorded him by the Botanical Society, related a few interesting incidents connected with his life.

His first vague impressions were connected with flowers, of roses and geraniums in his mother's window, at the early age of a year and a half. When he was a boy eight years of age the people in the district in which he lived frequently would go to him to find out the names of plants and where certain rare ones could be found.

One of the most interesting incidents that he related was a journey on foot from San Diego, California, to Santa Fé, New Mexico, in the year 1877, when there was not a line of railroad in all southern California, and only a stage line from San Diego to Santa Fé. Before starting out on this ventureesome journey he visited the old cemetery at the San Diego Mission. He said that he had always loved old graveyards and cloudy weather, and that music with a minor strain appealed to him especially. Among the black crosses in the graveyard was a white marble slab bearing the inscription "Edward L. Greene," with the dates of his birth and death. He who had borne this name had died at Dr. Greene's own age at that time. Dr. Greene wondered if this could be an omen, and whether it meant that he was starting out upon his last journey.

The country from San Diego to Yuma was a difficult one, and he carried only his portfolio and a few changes of socks, sending his money ahead in post office orders. At Yuma he met with a cordial reception, and was invited to hold religious services the next morning after his arrival in a public hall. He remained there over Sunday and Monday. Afterwards he saw in the little newspaper published at Yuma the following notice, concise and to the point in the expressive language of the frontier: "Last Saturday evening the Reverend Edward L. Greene reached Yuma on foot from San Diego. On Sunday morning he preached an excellent sermon to a fair congregation, and another in the evening to a large one. On Tuesday morning, refusing all offers of transportation or financial help, he continued his way eastward. This is solid pluck in big chunks. Boys, get acquainted with him; you will like him, and will find that he is no chicken-eating bummer."

The first Indians he encountered on this journey were standing in a clump of *Covillea* bushes looking at him curiously. Being rather apprehensive, he walked straight to them and fearlessly seized the arms of one of them as though inviting him to wrestle. This Indian, a very tall young man of splendid physique, noticed a ring on Dr. Greene's finger, a ring of red Australian gold. He asked if it were real gold. Dr. Greene took it off his finger and handed it to him, thinking that he would never see it again, but the Indisn, after tossing it up and catching it once or twice as if to test its weight, handed the ring back to him.

Dr. Greene reached Silver City in April and remained there three months collecting plants in all directions within a radius of several miles. The only botanist who had preceded him in this locality was Dr. Charles Wright, whose collections had made it classic ground. On one excursion Dr. Greene discovered a beautiful valley about forty miles from Silver City. It was most picturesque and contained cold and hot springs. When he

returned to the nearest settlement he described the marvelous beauty of this valley. A short while afterwards some of his friends, attracted to the valley by his description, camped in the same spot. They were all murdered there by Indians.

On his journey from Silver City to Santa Fé Dr. Greene was overtaken by a man on horseback, an agreeable-looking fellow, dressed in a business suit. He carried two pistols and a rifle slung over his shoulder. At the first stage station the two travelers stayed over night. The stranger seemed to be interested in Dr. Greene and his work. He was a fair-spoken, likable man, with polished manners. Dr. Greene noticed that he carried great rolls of greenbacks bulging from his pockets. Dr. Greene carried about 15 or 20 dollars of his own in a bag swung over his back. The two travelers proceeded onward the next day together. On the road the stranger asked Dr. Greene if he had ever encountered any bandits or outlaws, and said that he himself had spent many days with them in their mountain camps, and that as a rule they were good fellows to be with. The two men parted good friends. Afterwards Dr. Greene learned that his late companion was the leader of a well-known band of robbers.

In 1870 while botanizing on the slope of a snowy range west of Denver in a part of the country not yet settled Dr. Greene started up an inviting valley. After proceeding about a quarter of a mile he saw an Indian on horseback, then another, and another, until there must have been at least 150 Indians in the valley. One, who seemed to be their chief, squared his horse across the path and made signs that he wanted to examine the bag which Dr. Greene carried. When he opened the portfolio and saw nothing but plants he exclaimed, "Ugh! Medicine Man." He then asked Dr. Greene's name, and in return said that his own name was Colorao. This was the name of a notorious chief of the Utes, who was much feared by the whites. Less than three years afterwards this man murdered the entire agency to which the Utes belonged.

In conclusion Dr. Greene again expressed his appreciation of the honor accorded him and of the kind things which had been said regarding the matter of his life's work.

The society also arranged to present Dr. Greene with a book plate as soon as he should approve designs to be submitted by artists.

P. L. Ricker,
Corresponding Secretary

ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

The twenty-first meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held at the State Normal College on November 29, 1913. The following program was given:

10 o'clock

Appointment and reports of committees.

"Are Particular Abilities Necessary for the Pupil to Gain an Understanding of the Elementary and Secondary Mathematics as Usually Given at the Present Time," by Maurice J. Babb and Charles F. Wheelock.

Discussion.

"A Comparison at Equal School Ages of the Atttainments in Mathematics of the European and American Schoolboy with a Consideration of Causes and Remedies," by James C. Brown.

Discussion.

2 o'clock

"Mathematics as a Means to Culture and Discipline," by Albert Duncan Yocum.

Discussion.

"The Use of the Question in the Classroom," by Romiett Stevens.

Discussion.

The election of officers resulted as follows:

President: Eugene R. Smith, Park School, Baltimore, Md.

Vice-president: Herbert E. Hawkes, Columbia University, New York City.

Secretary: Howard F. Hart, Montclair High School, Montclair, N. J.

Treasurer: E. D. Fitch, De Lancey School, Philadelphia, Pa.

Council Members: Lao. G. Simons, City Normal College, New York City; W. H. Sherk, La Fayette High School, Buffalo, N. Y.

The next meeting will probably be held at New York City in February.

H. F. Hart,
Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA, MATHEMATICAL AND SCIENTIFIC SECTION

The second meeting of the session 1913–14 was held November 24. Professor Francis H. Smith presented a paper on "The Foucault Pendulum, and its Possibilities as a Convenient Lecture-room Experiment." A form of apparatus capable of quantitative demonstration within the time of 3 minutes was treated.

L. G. Hoxton,
Secretary

SCIENCE

FRIDAY, JANUARY 23, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE INFLUENCE OF FOURIER'S SERIES UPON THE DEVELOPMENT OF MATHEMATICS[1]

IN selecting a subject for to-day's address I have had the difficult task of interesting two distinct classes of men, the astronomer and the mathematician. I have therefore chosen a topic which, I trust, will appeal to both—trigonometric series. Though I propose to treat it only in its mathematical aspects, I shall try to do so in a broad way, tracing its *general* influence upon the trend of mathematical thought.

As you know, the theory of the infinite trigonometric series,

$$\text{(I.)}\quad f(x) = \tfrac{1}{2} a_0 + (a_1 \cos x + b_1 \sin x) + (a_2 \cos 2x + b_2 \sin 2x) + \cdots$$

is different *ab initio* from that of the power series,

$$P(x) = c_0 + c_1(x-a) + c_2(x-a)^2 + \cdots.$$

For the latter the fundamental element is x^n, of which the graph is, for positive x, a monotone increasing function, wholly regular, without peculiarities of any sort. It is therefore in no way surprising that the power series obtained by combining terms of form $c_n x^n$ define the most civilized members of mathematical society—the so-called analytic functions—which are most orderly in their behavior, being continuous throughout their "domains," possessing derivatives of all orders and a Taylor's series at every point; and so forth. On the other hand, the graph of $\sin nx$ or $\cos nx$ is a wave curve with crests and troughs, whose number in any x interval increases indefi-

[1] Address of the vice-president of Section A—Mathematics and Astronomy, American Association for the Advancement of Science, Atlanta, 1913.

nitely with n. Accordingly, the functions defined by infinite trigonometric series are obtained by compounding waves of varying intensity and different wave-lengths and may be almost infinitely complicated in their behavior. This fact was fraught with vital consequences for mathematical development.

A further distinction between the trigonometric and power series appears in respect to the values which their argument may take. The convergent power series $P(x)$ has significance for at least a limited domain of imaginary values of x; on the other hand, it is possible for trigonometric series to define functions which have no meaning except for real values of x. As, therefore, the trigonometric series has a functional content totally different from that of the power series, its influence was felt first, and primarily, in the development of the notion of a function of a real variable.

The concept *function* was at first vague, as vague and indefinite as our geometrical intuitions. It had its root in the 17th century in the analytic geometry of Descartes. Here the variation of y with x along a curve inevitably suggests the notion of a function. The first published definition of the term appeared in 1718 when John Bernoulli defined a function of a variable as "*an expression which is formed in any manner from the variable and constants.*" Thirty years later, in his "Infinitesimal Analysis," Euler defined it in like manner except that the function is now an "*analytic expression.*" What is meant by "analytic expression" is not explained, but from his definition of special classes of functions it would appear that the term denoted an expression put together in terms of the variable and constants by a finite or infinite number of operations of addition, subtraction, mulitiplication, and division. Differentiation and integration were also undoubtedly permissible.

About this time there began the famous controversy over the mathematical representation of a vibrating string. This satisfies the well-known differential equation

$$\frac{\partial^2 w}{\partial t^2} = a^2 \frac{\partial^2 w}{\partial x^2},$$

where a is a certain constant, x the position of a particle on the string when taut, and w its transverse displacement at time t. A solution of this problem for the case of fixed end points was given by d'Alembert in 1747 under the form

$$w = f(x + at) - f(at - x),$$

where $f(x)$ denotes an arbitrary function whose nature he apprehended too narrowly. But he claimed to have the general solution inasmuch as his solution involved an *arbitrary* function.

This shot into mathematics the question: *What is an arbitrary function?* Even to-day this question is a vexing one, owing to disagreement in the point-set theory concerning certain principles of logic which cluster around the "*Princip der Auswahl*" as a center. But mathematicians had not then arrived at the subtleties of the present day. Their difficulties were really caused more by imperfect notions concerning a function than by the degree of arbitrariness. On the basis of the above definition of a function then current, Euler maintained that d'Alembert's solution was particular, rather than the most general possible. He rightly apprehended the nature of the physical problem and saw that the motion of the string subsequent to the initial instant was completely determined by the initial form of the string and the initial velocities of its points. Now the initial shape of the string could be a continuous geometrical curve composed of successive pieces whose forms are absolutely independent of one

another. To represent these pieces, Euler claimed that an equal number of different analytic expressions, or arbitrary functions, were necessary. Hence, as d'Alembert's solution involved only *one* arbitrary function, it could not be the general solution of the problem.

In these considerations of Euler there is a sharp antithesis between geometry and analysis. In Euler's thought the independent pieces of the above curve formed "*curvæ discontinuæ seu mixtæ seu irregulares.*" There was a blind belief that the definition of a curve in any interval by a mathematical expression carried with it a definite continuation of the curve beyond the interval, the violation of which was a violation of analysis. Thus the question was raised as to the relative power of mathematically constructible expressions and of geometric representation, and it was decided that geometric form transcends analytic expression rather than the converse.

The dual character of this controversy was changed into a triple one by Daniel Bernoulli, who first introduced Fourier's series into physics and obtained the solution of the equation of the vibrating string with fixed end points under the form of a trigonometric series,

$$y = \sum_{n=1}^{\infty} a_n \sin \frac{n\pi x}{l} \cos \frac{n\pi a t}{l},$$

where l denotes the length of the string. The separate terms of this series give the tones and overtones of the vibrating string. Inasmuch as this solution is compounded of an infinite number of tones and overtones of all possible intensities, Daniel Bernoulli claimed that he had obtained the general solution of the problem.

For $t = 0$ the above equation gives as the initial form of the string,

$$y = \sum_{n=1}^{\infty} a_n \sin \frac{n\pi x}{l}.$$

The question then at once arose whether d'Alembert's arbitrary function was capable of expansion into such a sine series. To Euler this seemed unthinkable. It was, so to speak, against the laws of the game, it was contrary to the rules of analysis that arbitrary, non-periodic functions could be represented in terms of periodic functions. Hence to Euler, Bernoulli's solution of the problem appeared even more limited than that of d'Alembert.

I have not the time to follow further this controversy, nor to show how d'Alembert and Lagrange united with Euler in declaring Daniel Bernoulli wrong in his claim. Yet not withstanding this overwhelming preponderance of authority Daniel Bernoulli was right. The controversy gradually languished without any clear conclusion till 1807, twenty-five years after Bernoulli's death, when Fourier presented to the French Academy one of the first of his communications which were summed up in 1822 in his "Analytic Theory of Heat." In this communication he startled Lagrange with the absolutely revolutionary doctrine that an arbitrarily given curve or function, irrespective of its nature, could be represented in any interval by a trigonometric series. Fourier sought no strict proof of his assertion, but the concrete examples which he gave vindicated its force. The precise limitations necessary to make the assertion exactly true remained, and to some extent still remain, for his successors to ascertain.

Fourier's result not merely vindicated Daniel Bernoulli's claim for his series, but showed that his claim fell far short of the reality. At a single blow it shattered hopelessly the notion of Euler and his contemporaries that a mathematical function could be carried continuously beyond the interval of definition in only a single way. But Fourier's examples went further than this. The arbitrary curve which he represented

by his series (I) could consist of separate pieces of any sort, not merely having no logical or definitional dependence on one another, but even not connecting successively at their ends. Thus by virtue of Fourier's assertion the power of representation through analytic expression is at least as great as the power of geometric picturization.

When once it was realized that mathematical expression could be adapted to the most diverse and unrelated demands upon it, no logical stopping-point could be seen short of the definition to-day accepted for a function of a real variable, and often referred to as the Dirichlet definition of a function. If, namely, to every value of x in an interval there corresponds a definite value of y (no matter how fixed or determined), y is called a function of x. For example, y may be equal to $+1$ at all rational points which are everywhere dense in any interval, and equal to 0 at the irrational points which are likewise everywhere dense. The Fourier series has thus necessitated a radical reconstruction of the notion of a function. *This is the first of its services which I wish to emphasize, the development and complete clarification of the concept of a function.*

Without loss of generality the interval in which the representation of the function by the series is required may be supposed to lie between $-\pi$ and $+\pi$. The series has then the form (I.) hitherto assumed. To determine its coefficients from the function Fourier used for the most part the equations,

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\cos nx\,dx,$$
$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\sin nx\,dx;$$

but this determination, as Fourier himself stated, had been made by Euler before him. Trigonometric series whose coefficients can be obtained from the function represented in this manner are now called *Fourier's series* in distinction from trigonometric series whose coefficients can not be so obtained through integration. I have, however, in the title of my paper used the term "Fourier's series" in the older and broader sense as synonymous with all series of the form (I.).

The consideration of trigonometric series from a strict mathematical standpoint marks a second epoch in their history. This began with Dirichlet in 1829 in a memoir remarkable for its combination of clearness and rigor. Here he first determined accurately a set of sufficient conditions for the expansion of a function into a Fourier series. These familiar "Dirichlet conditions" it is scarcely necessary to repeat.

The extension of his results was at once sought, in particular by Riemann in a Göttingen Habilitations-Dissertation, which bore the title "Ueber die Darstellbarkeit einer Function durch eine trigonometrische Reihe." Riemann's aim was, however, to determine the *necessary* conditions for the representability of the function by the series. Must the function be integrable, as required in the sufficient conditions of Dirichlet? Must it have only a finite number of maxima and minima and of discontinuities? Such questions as these were easily answered by him in the negative, and a flood of light was poured upon the problem of representability but without making visible its complete solution. Possibly it was for this reason that this Habilitationsschrift, though delivered in 1854, was not published until thirteen years later, and then only after Riemann's death. Yet the work is a classic. As has been said of the poet Coleridge, so it could be said of Riemann, he wrote but little, but that little should be bound in gold.

To put the theory of Fourier's series on

a broader basis, Riemann perceived that first of all it was necessary to sharpen and widen the concept of an integral. Initially Leibnitz had thought of integration as a summation process, but this notion was forced into the background by its definition as the reverse of differentiation, until revived by Cauchy in 1823. He then defined the integral of a *continuous* function as most of us were taught to define it. The interval of integration was divided into n parts δ_i, each δ_i was multiplied by the value of the function $f(x_i)$ at its beginning, and the integral was defined as the limit of the sum $\Sigma\delta_i f(x_i)$ when the number of parts increased indefinitely, their size diminishing indefinitely. Because of the continuity of the function this definition of the definite integral was equivalent to that framed by means of the reverse process of differentiation. Riemann dismisses altogether the requirement of continuity for the function, and in forming the sum multiplies each subinterval δ_i by the value of the function, not necessarily at the beginning of the interval, but at a point ξ_i *arbitrarily* assumed in the subinterval. If, then, a limit exists for the sum $\Sigma\delta_i f(\xi_i)$, irrespective of the manner of partitioning the interval and of the choice of the points ξ_i, this is called the integral. Thus he redefined the fundamental concept of the integral calculus, making it entirely independent of the differential calculus. This definition, often referred to as the Riemann definition of an integral, has now become the universally accepted one and is the basis of scientific treatment of the integral calculus. *Thus a second service of Fourier's series has been in laying the foundation of the modern integral calculus, and in such wise that it bid fair to completely eclipse the differential calculus in importance and reach.*

Riemann's memoir may also be characterized as the beginning of a theory of the mathematically discontinuous. The work of Fourier had disclosed that mathematical expressions could portray functions with breaks, and the exacter but more limited investigation of Dirichlet drew still further attention to discontinuities. Riemann's definition of an integral did more; with one leap it planted the discontinuous function firmly upon the mathematical arena. In his integrable functions was comprised a class of functions whose discontinuities were infinitely dense in every interval, no matter how small—though indeed, as we now know, they are not totally discontinuous. One example which he gave was the integrable function defined by the convergent series,

$$1+\frac{(x)}{1^2}+\frac{(2x)}{2^2}+\frac{(3x)}{3^2}+\cdots,$$

in which (nx) denotes the positive or negative difference between nx and the nearest integral value, unless nx falls half way between two consecutive integers, when the value of (nx) is to be set equal to 0. The sum of the series was shown to be discontinuous for every rational value of x of the form $p/2n$, where p is an odd integer relatively prime to n.

This example and others, such as that of an integrable function with an infinite number of maxima and minima which was incapable of representation by a Fourier's series, were exceedingly stimulating. The investigation so impressed the imagination of Hermann Hankel as to call forth his notable memoir "Uber die unendlich oft oszillierenden und unstetigen Functionen" in which he unfolds his principle of "condensation of singularities," a memoir so important that it has even been said to "entitle him to be called the founder of the independent theory of functions of a real variable." It would appear to me that this distinction could be assigned with equal propriety to Riemann, for historically the

first of the two or three principal sources of this theory is to be found in Riemann's application of integration to discontinuous functions in his memoir on "the representability of a function by Fourier's series."

The above example of Riemann is notable for giving a mathematical expression for a discontinuous function incapable of graphical representation. I have already pointed out how Euler conceived of graphs so arbitrary as to be impossible of representation through an "analytic expression." The scales were now turned decisively to the other side, though it was not till later that it was recognized that our geometric figures have only an approximating character which our mathematical equations refine.

But the full power of mathematical expression was not realized until 1872–1875, when Weierstrass startled the mathematical world with an example (first published by Du Bois Reymond in 1875) of a continuous function having nowhere a derivative, or, in other terms, of a continuous curve without a tangent. The function given by Weierstrass was a trigonometric series

$$\sum_{n=1}^{\infty} b^n \cos a^n \pi x,$$

in which b is a positive constant less than 1 and a a fixed odd integer large enough to make ab exceed a certain value. Weierstrass states also that Riemann is supposed to have shown that the series

$$\Sigma \frac{\sin n^2 x}{n^2}$$

represented a function of like property, but the proof was not known. The failure of the continuous function of Weierstrass to be differentiable is due to the possession of an infinite number of maxima and minima in any interval, however small.

This example completed the separation between differentiable and continuous functions. It shows that *the former are only a subclass of the latter,* a result not even surmised by the boldest geometrical intuition. *This is the third influence of Fourier's series which I wish to emphasize.* So far as I know, this is the only one of its results which vitally affects geometric theory. It reveals the transcendence of analysis over geometrical perception. It signalizes the flight of human intellect beyond the bounds of the senses.

I return now to trace further the march of the function theory of the real variable. The second principal element in its formation seems to me to have been the concept of *uniform convergence.* This also seems to have been suggested chiefly by study of trigonometric series. Originally it was supposed that the sum of a convergent series of continuous functions shared the common properties of its terms and accordingly was continuous. Even so great a mathematician as Cauchy fell for a time into this error. The fallaciousness of this assumption was first pointed out by Abel in 1826 in his well-known memoir on the binomial series. Here he also discusses the series

$$f(\phi) = \sin\phi - \frac{\sin 2\phi}{2} + \frac{\sin 3\phi}{3} - \cdots, \qquad (2)$$

every term of which is continuous. Clearly the sum vanishes whenever ϕ is a multiple of π. If ϕ lies between $m\pi$ and $(m+1)\pi$, the sum is $\phi/2 - \nu\pi$, where ν denotes the

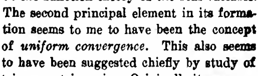

Fig. 1.

half of m or $m+1$, according as m is even or odd. Consequently, when ϕ passes through an odd multiple of π, the sum has a discontinuity of amount π, as is indicated in the adjoining graph. This re-

sult is in sharp contrast with the continuity of the sum which he demonstrates for the binomial and other real power series. At the same time he establishes the circular form of the region of convergence of the binomial series. Here, then, appears the initial cleavage between the theories of real and of analytic functions.

The difference between the trigonometric and the power series in respect to continuity is naturally to be sought in the character of the convergence at the points of continuity and of discontinuity. This difference was pointed out by Stokes in 1847 and by Seidel a year later. Both discovered the infinitely increasing slowness of convergence of the series on approaching a discontinuity of its sum. Consequently a discontinuity can not be enclosed in any interval, however small, in which the convergence is throughout "von gleichem Grade." In more modern parlance, the convergence is non-uniform. Seidel in his introduction explicitly points out that the erroneousness of Cauchy's conclusion (see above) is obvious from the existence of discontinuities in functions represented by Fourier's series, and he is evidently incited thereby to seek a cause for the discontinuity. The origin of Stokes's study is sufficiently obvious from its title: "On the Critical Values of the Sum of Periodic Series." His failure to appreciate the importance of his own convergence discussion is evident from the fact that it is not even mentioned in the opening analysis of his lengthy memoir.

A third discoverer of uniform convergence was Weierstrass, who is known to have been in possession of the notion as early as 1841. Through his followers (Heine and others) it gradually percolated into the mathematical literature. Unlike Seidel and Stokes, he thoroughly realized its importance. As Osgood has well said in his *Functionentheorie*, he developed uniform convergence into one of the most important organs "(methods) of modern analysis." The origin of the notion in the case of Weierstrass I have been unable to ascertain. A conjecture or surmise may therefore be pardoned. As is well-known, the work of Weierstrass is rooted in that of Abel, the central theme or core being the theory of Abelian functions. It would not seem to be altogether improbable that both Weierstrass's theory of the analytic function and his concept of uniform convergence had as their starting point Abel's memoir on the binomial series. For here, on the one hand, with the demonstration of the circular form of the region of convergence of the binomial series, we find a proof of the continuity of the series which involves implicitly the idea of uniform convergence; on the other hand, we have in the footnote a series with discontinuities due, in fact, to non-uniform convergence. It would be a small matter for the discriminating Weierstrass to see that the continuity of the sum could not be carried over from the binomial to the trigonometric series, because there was not the same kind of convergence in the latter case. If this surmise is correct, the discovery of uniform convergence in the case of the third discoverer also is closely connected with a Fourier series.

I have dwelt at some length on uniform convergence because its discovery marks both the culmination of the first and older epoch in the treatment of functional series, and the beginning of a new one. In uniform convergence and a study of the discontinuous we have sought for the chief springs of the modern *theory of functions of a real variable. By so doing we are led to assign as a fourth great service of Fourier's series the genesis of this theory.* It is not to be forgotten, however, that other sources have also copiously contributed. The morphology of one member of a body

must be in many ways perverted, if studied without correlation to the other members. But, after all, it is the Fourier series which gave the initial push and chief impetus to the construction of the function theory of the real variable.

This becomes still plainer if we take into consideration the comparatively recent point-set theory. Originally an off-shoot of the real function theory and still often treated by itself, it has been largely absorbed back into this theory, and its concepts already permeate analysis. Its founder was George Cantor, who was trained in the exact yet fertile school of Weierstrass. His earliest papers presaging this theory relate to a trigonometric series.

Two problems occupy his attention. The first is to show that if the series $\Sigma\,(a_n \sin nx + b_n \cos nx)$ is convergent throughout an entire interval, except possibly for a finite number of points, the coefficients a_n and b_n have for $n = \infty$ the limit 0. The second is to establish the uniqueness of the development of a function into a trigonometric series; in other words, to prove that when $\Sigma\,(a_n \sin nx + b_n \cos nx)$ is identically 0 over an interval, then each and every a_n and b_n must be 0. The requirement of convergence of the sum in the one case and of its vanishing in the other, was originally made for the entire interval, but Cantor found that it could be remitted for certain infinite aggregates of points without affecting the truth of the conclusions. He was led consequently to introduce the notion of the "*derivative of a point-set.*" Consider with him the set of points for which the requirement is omitted, and suppose that they cluster in infinite number in the vicinity of any point. This will be called a limit-point of the set. The totality of these limit-points is called the first derived set, or first derivative. This derived set of points may also have cluster points which form the second derivative; and so on. After introducing this concept, Cantor proved that the requirement could be remitted for any set of points whose nth derivative contains only a finite number of points and whose $(n+1)$th derivative accordingly vanishes.

In these very early papers of Cantor we have very clearly the beginning of his point-set theory. His attention is here concentrated upon an infinite aggregate of points, and the notion of the derived point-set was the first of the concepts by means of which he is able to distinguish between different infinite aggregates of points. Prior to Cantor no effort was made to distinguish qualitatively between them. To be sure, mathematicians were thoroughly conversant with the distinction between a continuous curve or set of points, on the one hand, and a merely dense aggregate of points such as the totality of points with rational coordinates. The raw material lay at hand for a beginning, especially in the work of Riemann and others on integration. Cantor alone saw the imperativeness of the need. In comparing infinite sets of objects and seeking a theory of the truly infinite he blazed a new path for the human mind. *As a fifth and a mighty influence of Fourier's series we have, therefore, to record the historic origin of the theory of infinite aggregates.*

Thus far in my sketch I have traced one strong, single current of influence of the Fourier's series. I have now to indicate some other effects without close relation to the foregoing.

In Fourier's "Analytical Theory of Heat" there are found what are said to be the first instances of the solution of an infinite number of linear equations with an infinite number of unknowns. He has, for example, to determine the coefficients in the equation:

$$1 = a \cos y + b \cos 3y + c \cos 5y + \cdots.$$

For this purpose he differentiates an even number of times, obtaining thus the system of equations

$$0 = a \cos y + b3^n \cos 3y + c5^n \cos 5y + \cdots \; (n = 2, 4, \ldots)$$

Combining this with the preceding equation and putting $y = 0$, he obtains an infinite number of equations of first degree with an infinite number of unknowns, a, b, c, $\cdots$. To solve these he uses the first m equations to determine the first m unknowns, suppressing all the other unknowns, and finally determines their limiting values as m increases indefinitely. There is no time to point out the lack of rigor. Fourier uses his mathematics with the delightful freedom and naïveté of the physicist or astronomer who trusts in a mathematical providence.

This suggestive line of attack was not followed up, and indeed could not be, prior to the development of a theory of infinite determinants. When such a system of linear equations with an infinite number of unknowns came again to the foreground, the inciting cause was again a trigonometric series. I refer, as you know, to the work of our own astronomer, Hill. In his memoir on the "Motion of the Lunar Perigee" he had before him a differential equation of the following form, with numerical coefficients:

$$\frac{d^2w}{d\tau^2} = 2w\left(_2 + \theta_1 \cos 2\tau + \theta_2 \cos 4\tau + \cdots\right).$$

Assuming a solution in the form

$$w = e^{ic\tau} \sum_{n=-\infty}^{n=+\infty} b_n e^{2in\tau}$$

(which except for the factor $e^{ic\tau}$ is only a trigonometric series under another guise), Hill obtains for the determination of c and the b_n an infinite system of equations linear in the b_n. The elimination of the b_n then gives c as the root of a certain infinite determinant, and then the values of the b_n are also found by use of infinite determinants.

The importance of Hill's results at once attracted the genius of Poincaré whose attention had, in fact, been previously drawn by Appell to an infinite system of linear equations. Poincaré now proceeded to consider the question of the convergence of infinite determinants, and in so doing laid a sound foundation for a new mathematical subject. In this new theory of infinite determinants the central thought is the passage, under restrictions to be properly ascertained, from a finite to an infinite system of linear equations. This principle here employed has been since applied in an even more striking manner by Fredholm, who was led through its use to his historic solution of a class of integral equations. In the theory of these equations the infinite determinant plays an indispensable rôle. *A sixth influence of Fourier's series is thus seen in the origin of a theory of infinite determinants,* also indirectly in the theory of integral equations for which it has supplied an important tool.

The seventh and the last influence on which I shall specifically dwell is more subtile, not so easily pointed out or demonstrated as some of the foregoing, but nevertheless one of the most far-reaching and probably the most pervasive of all. The physicist, astronomer, or mathematician has again and again to expand an arbitrary or assigned function into a series of functions, the nature of which varies with the problem before one. When once the idea and method of expressing an arbitrary function in series of sines and cosines have been won, they can be extended to other series of functions, as for instance series of Bessel's functions, zonal harmonics, Lamé polynomials, spherical harmonics. For such developments the trigonometric series with its

applications has repeatedly served as a guide post. Numberless analogous results have been suggested thereby, though without definite statement of the fact. To take an example at random, the relation

$$\int_0^1 P_{2n}(x)P_{2m}(x)dx = 0 \qquad (m \neq n)$$

has its trigonometric analogues

$$\int_0^\pi \cos n\theta \cos m\theta \, d\theta = 0.$$

Who can deny, or who can affirm, in many such individual instances that the suggestion came from the trigonometric series? Yet in the bulk the debt is so great that he who runs can read it.

It is especially in connection with boundary value problems that we encounter series of functions. Now the trigonometric series was the inevitable tool for the first boundary value problems—those of vibrating strings, rods, columns of air, etc. Later, when Fourier crystallized the boundary value problems into classic shape, he used trigonometric series and, to lesser degree, similar series of Bessel's functions, obviously because these afforded him the simplest tools for the simplest problems. From series of sines of multiple angles he was led by certain problems in heat conduction to series of form $\Sigma c_i \sin a_i x$, where the a_i are roots of a certain transcendental equation. Thence the orientizing influence of Fourier's series is continued down to the modern development of normal functions in the theory of integral equations. All such influences are in the very warp and woof of mathematical development and can not be disentangled. To minimize or ignore them would be to give a distorted picture. They form a most vital and leading part of the mighty theory of harmonic and normal functions and of the boundary value theory.

The extent of these influences in the past gives rise naturally to the question of whether the trigonometric series will continue to exert such a moulding influence in the future. Certain results of Baire to be shortly mentioned incline one to answer negatively. Yet the questions regarding the convergence of the series and the character of the functions which it can represent are even to-day incompletely answered. When new implements are invented, it is still to these unanswered questions that the investigator naturally turns to test their worth, as, for example, Lebesgue with his great new concept of an integral which has application when Riemann's integral is void of sense, or Fejér with a method of summing a divergent series. Also the Fourier series still offers an occasional surprise. Who indeed would have anticipated Gibbs's discovery, since extended by Bôcher, which relates to the approximation curve $y=S_n(x)$, obtained by equating y to the sum of the first n terms of the series (2) above? As n increases indefinitely, the amount of the oscillation of the curve in the vicinity of each point of discontinuity of the limit does not tend toward the measure of the discontinuity, as would be supposed, but to this value increased in a certain definite ratio! But it may be reasonably expected that these surprises will become fewer and less important.

In this brief review I have neglected certain less analytic aspects, such as trigonometric interpolation and the use of the series in computation and in the perturbation theory. It has also not been necessary to emphasize the simplicity of structure of the series and its adaptation to computation. Neither do I need to speak of its correspondence in structure to so many periodic phenomena of nature, sound, light, the tides, etc. But I do wish, in closing, to emphasize and examine further, one aspect implied in all my preceding con-

siderations, the wonderful *pliability* of the series.

It was this pliability which was embodied in Fourier's intuition, commonly but falsely called a theorem, according to which the trigonometric series (I.) "*can express any function whatever between definite values of the variable.*" This familiar statement of Fourier's "theorem," taken from Thompson and Tait's "Natural Philosophy," is much too broad a one, but even with the limitations which must to-day be imposed upon the conclusion, its importance can still be most fittingly described as follows in their own words: The theorem "*is not only one of the most beautiful results of modern analysis, but may be said to furnish an indispensable instrument in the treatment of nearly recondite question in modern physics. To mention only sonorous vibrations, the propagation of electric signals along a telegraph wire, and the conduction of heat by the earth's crust, as subjects in their generality intractable without it, is to give but a feeble idea of its importance.*"

Truly, the theorem is so comprehensive in its mathematical content that we mathematicians may well query with one of my colleagues whether it may not have conditioned the form of physical thought itself—whether it has not actually forced the physicist often to think of complicated physical phenomena as made up of oscillatory or harmonic components, when they are not inherently so composed.

It is this same pliability of the series that has been a source of perpetual delight and surprise to the mathematician. It has revealed an undreamt-of power in analysis. It has stimulated intuition and vigor, and has helped to usher in a modern critical era in mathematics similar in spirit to the Greek period. It has separated differentiable from continuous functions; it has put the integral calculus on a basis of independence of the differential calculus; it has focused attention upon sets of irregularities and discontinuities whose study has started the point-set theory; it has opened the field of discontinuous functions to analysis and, above all, has engendered a theory of functions of the real variable.

To the mathematician the theory of analytic functions for some time appeared to be of much greater importance than the freaky theory of the real variable, because almost all the important functions of mathematics are analytic. Also, the same has been hastily assumed for physics because the real and imaginary components of an analytic function are harmonic functions satisfying Laplace's equation. But this is to ignore features of at least equal, if not of superior, importance. Not long ago many thought that the mathematical world was created out of analytic functions. It was the Fourier series which disclosed a *terra incognita* in a second hemisphere.

Here, in the new hemisphere, the mathematician has advanced beyond the boundary of the trigonometric series. It has been found that discontinuous functions representable through such series form a thoroughly restricted class. They belong to what Baire calls the first class of functions which are limits of convergent sequences or series of continuous functions, themselves of "class 0." These in turn may be used to generate new functions. Even as non-uniformly convergent Fourier series may give rise to discontinuous functions of Class 1, so non-uniformly convergent series of functions of this class may give a new sort of functions of Class 2, and so on. Indeed, to every transfinite number a of the first or second class there corresponds, as Lebesgue has shown, a definite class of functions. *Thus the Fourier series has, after all, a very limited range of representation*

in the totality of functions mathematically conceivable.

Even for functions of Class 0 or 1 the trigonometric series has a limited power of representation. This is manifest from an example given by Paul Du Bois Reymond of a continuous function which can not be represented by a trigonometric series. It remains to determine in the future just what properties are necessary and sufficient to characterize those functions of Classes 0 and 1 which are expressible by means of trigonometric series.

Earlier in my paper I pointed out that the generality of functions representable through Fourier's series was so great that the mathematician was led irresistibly to the Dirichlet definition of a function. If, namely, to every value of x in an interval we have a corresponding value of y, then y is called a function of x, no matter how the correspondence is set up, whether by a graph, a mathematical expression, a law, or any other way. To-day the pendulum has swung back to the old question of Euler. The study of representability in terms of trigonometric series has been succeeded by the broader question of the possibility of analytic expression in general. Now every continuous function, as is well known, can be represented by a uniformly convergent set of polynomials. Starting then from the totality of polynomials as a basis of functions for Class 0, we arrive successively at Baire's and Lebesgue's classes of functions corresponding to or, if you prefer, marked, by the transfinite numbers of the first and second classes.

Do these different classes of functions comprise all which are "*analytically expressible*"? Before answering the question it is necessary first to sharply define the phrase "analytically expressible." This is done by Lebesgue. Then, after broadening the content of these classes in a manner I have not the time to describe, he goes on to show that they do in truth comprise all such functions. The final question then confronts us: Are all possible functions included which are defined in accordance with the general definition of Dirichlet? In other words, are there functions *incapable of being "analytically expressed"*? Lebesgue by an example shows that this is the case. Our study of the Fourier series opened with the question: What is an arbitrary function? Here, at last, apparently, we have discovered the existence of a function of such a height or depth of arbitrariness as to be mathematically inexpressible. Having started with the Fourier series on a voyage of exploration, shall we conclude by saying that there is for us an unattainable pole?

Edward B. Van Vleck
University of Wisconsin

UNIVERSITY REGISTRATION STATISTICS

The registration returns for November 1, 1913, of thirty of the leading universities of the country will be found tabulated on the following page. Specific attention should be called once again to the fact that these universities are neither the thirty largest universities in the country, nor necessarily the leading institutions. The only universities which show a decrease in the grand total attendance (including the summer sessions) are Harvard, Western Reserve and Yale, the attendance of the two institutions last named having remained practically stationary. The largest gains in terms of student units, including the summer attendance, but making due allowance by deduction for the summer session students who returned for instruction in the fall, were registered by New York University (965), Illinois (944), Columbia (927), Wisconsin (749), Pennsylvania (681), California (614), Iowa (598),

Ohio State (503), Chicago (483), and Michigan (388). Last year there were only five institutions that showed a gain of over 300 students, namely, Columbia, California, New York University, Texas and Harvard. Omitting the summer session attendance, the largest gains this year have been made by Illinois (887), New York University (772), California (640), Pennsylvania (571), Iowa (538), Wisconsin (493), Ohio State (434), Michigan (381), Chicago (353), Syracuse (305), Washington University (267), and Columbia (255). It will thus be seen that this year twelve institutions exhibited an increase of over 200 students in the fall attendance, as against eight in 1912 and four in 1911. Of these institutions eight are in the west and four in the east.

According to the figures for 1913, the thirty institutions, inclusive of the summer session rank as follows: Columbia (9,929), California (7,071), Chicago (6,834), Michigan (6,008), Pennsylvania (5,968), Wisconsin (5,890), Harvard (5,627), Cornell (5,612), New York University (5,508), Illinois (5,259), Ohio State (4,111), Minnesota (3,932), Northwestern (3,877), Syracuse (3,845), Yale (3,263), Missouri (3,135), Texas (3,106), Nebraska (2,850), Kansas (2,610), Iowa (2,542), Tulane (2,298), Indiana (2,271), Pittsburgh (1,906), Cincinnati (1,871), Stanford (1,756), Princeton (1,599), Western Reserve (1,370), Johns Hopkins (1,311), Washington University (1,225), and Virginia (885), whereas last year the order was Columbia, California, Chicago, Harvard, Michigan, Cornell, Wisconsin, Minnesota, Pennsylvania, New York University, Illinois, Northwestern, Ohio State, Syracuse, Yale, Texas, Missouri, Nebraska, Kansas, Tulane, Iowa, Cincinnati, Pittsburgh, Stanford, Princeton, Western Reserve, Washington University, Johns Hopkins, Virginia. If the summer-session enrollment be omitted, the universities in the table rank in size as follows: Columbia (6,403), Pennsylvania (5,305), Michigan (5,304), California (5,225), Harvard (4,922), Illinois (4,835) and New York University (4,835), Cornell (4,760), Wisconsin (4,450), Northwestern (3,776), Chicago (3,719), Ohio State (3,708), Syracuse (3,699), Minnesota (3,616), Yale (3,263), Missouri (2,547), Nebraska (2,482), Texas (2,373), Kansas (2,308), Iowa (2,294), Pittsburgh (1,906), Cincinnati (1,871), Stanford (1,743), Princeton (1,599), Indiana (1,417), Western Reserve (1,370), Tulane (1,244), Washington University (1,225), Johns Hopkins (1,012) and Virginia (885), whereas last year the order was: Columbia, Michigan, Harvard, Cornell, California, Pennsylvania, New York University, Wisconsin, Illinois, Northwestern, Minnesota, Syracuse, Chicago, Ohio State, Yale, Nebraska, Missouri, Texas, Kansas, Cincinnati, Pittsburgh, Iowa, Stanford, Princeton, Western Reserve, Tulane, Washington University, Virginia, and Johns Hopkins.

Including the summer-session attendance the largest gains in the decade from 1903 to 1913 were made by Columbia (5,372), California (3,594), New York University (3,331), Pennsylvania (3,324), Chicago (2,688), Wisconsin (2,669), Ohio State (2,423), Cornell (2,174), Michigan (2,082) and Illinois (2,020).

So far as the individual faculties of the various universities are concerned, Harvard with 2,350 men and 564 women (Radcliffe College) leads in the number of college undergraduates, being followed by California, with 1,112 men and 1,626 women; Michigan, with 1,736 men and 784 women; Stanford, with 1,243 men and 500 women; Chicago, with 936 men and 767 women; Kansas, with 942 men and 688

	California	Chicago	Cincinnati	Columbia	Cornell	Harvard	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Pittsburgh	Princeton	Stanford	Syracuse	Texas	Tulane	Virginia	Washington University	Western Reserve	Wisconsin	Yale
College, Men	1112	936	200	841	} 1120	2350	427	694	610	178	942	1736	639	834	541	486	479	485	} 409	305	1267	1243	} 1340	811	166	396	152	459	828	1402
College, Women	1626	767	419	623		564	402	423	553	...	688	784	882	516	733	221	609	412		87	...	500		709	152	...	229	358	776	...
Scientific Schools*	828	...	406	665	1343	76	1001	248	221	79	372	1282	638	360	306	233	80	811	657	266	156	...	308	288	164	101	169	...	775	1133
Law	142	211	...	450	267	695	106	85	201	...	174	553	193	103	200	771	294	181	381	143	...	140	291	339	94	257	80	109	161	130
Medicine	119	191	84	341	107	306	445	132	112	368	107	353	172	75	102	432	178	...	283	123	...	64	96	170	399	102	60	164	79	49
Non-professional graduate schools	408	480	170	1496	315	489	268	83	130	219	99	225	127	123	169	369	85	121	438	46	176	134	75	77	27	43	57	9	290	334
Agriculture	530	...	...	...	1354	...	792	...	...	...	...	...	464	501	423	...	...	889	...	...	...	...	70	38	...	...	...	...	968	...
Architecture	†	...	...	143	143	61	351	...	...	...	23	120	43	...	1	...	...	65	259	...	...	...	50	54	25	...	46	...	...	...
Art	†	...	...	...	...	...	†	58	42	...	20	†	...	...	64	...	46	...	...	...	...	...	178	...	85	...	305	...	...	53
Commerce	280	160	97	...	...	113	282	...	...	...	...	†	...	...	22	2013	567	...	1430	...	...	...	...	57	...	...	...	...	374	...
Dentistry	90	...	...	...	...	203	94	...	244	...	...	282	268	...	...	...	566	...	589	209	...	...	...	...	55	...	111	139	...	...
Divinity	...	125	...	...	...	56	...	...	...	...	...	...	...	...	...	...	233	...	...	...	...	...	...	...	...	...	...	...	...	100
Forestry	†	...	...	...	...	9	†	...	...	...	...	†	41	†	36	...	...	65	...	...	...	...	220	...	...	...	...	...	12	32
Journalism	...	...	...	106	...	...	†	73	...	...	...	†	...	64	...	†	39	...	...	...	...	...	...	...	21	...	...	...	91	...
Music	†	...	...	16	...	...	78	93	87	...	130	†	25	...	...	...	407	...	26	...	...	...	925	...	73	...	...	...	81	85
Pedagogy	†	287	240	1670	...	...	...	77	†	...	181	†	87	182	164	420	122	166	699	421	...	...	25	443	91	...	...	...	42	...
Pharmacy	114	...	...	441	...	...	255	...	57	...	61	96	95	...	23	...	135	92	...	209	...	...	...	63	7	...	...	124	40	...
Veterinary Medicine	†	...	...	...	122	...	†	...	...	...	...	...	...	...	...	11	...	163	125	...	...	...	...	...	...	...	...	...	...	...
Other Courses	...	808	486	...	...	...	350	...	86	168	...	...	10	...	...	...	296	280	9	157	...	...	233	...	...	...	48	45	45	...
Deduct Double Registration	24	246	231	389	11	...	16	549	49	...	489	127	68	211	302	121	360	22	...	60	...	338	112	676	115	14	32	37	112	55
Total	5225	3719	1871	6403	4760	4922	4835	1417	2294	1012	2308	5304	3616	2547	2482	4835	3776	3708	5305	1906	1599	1743	3699	2373	1244	885	1225	1370	4450	3263
Summer Session 1913	2363	3771	...	4539	1392	797	713	1084	426	347	510	1408	531	810	511	933	193	703	865	...	...	38	260	981	1163	‡	...	...	2120	...
Deduct Double Registration	517	656	...	1013	540	92	289	230	178	48	208	704	215	222	143	260	92	300	202	...	...	25	114	248	109	...	...	...	680	...
Grand Total 1913, Nov. 1	7071	6834	1871	9929	5612	5627	5259	2271	2542	1311	2610	6008	3932	3135	2850	5508	3877	4111	5968	1906	1599	1756	3845	3106	2298	885	1225	1370	5890	3263
Grand Total 1912, Nov. 1	6457	6351	1924	9002	5412	5729	4315	2192	1944	1058	2403	5620	3737	2871	2811	4543	3632	3608	5287	1833	1568	1670	3529	3016	2249	799	958	1378	5141	3265
Grand Total 1910, Nov. 1	4552	5883	1416	7411	5169	5329	4659	2132	1957	890	2246	5339	4972	2678	2733	3947	3543	3181	5187	...	1451	1648	3248	2597	1985	688	796	1274	4745	3287
Grand Total 1908, Nov. 1	3644	5114	1364	5677	4700	5342	4400	2113	2356	707	2086	5188	4607	2558	3154	3951	3113	2700	4555	...	1314	1541	3204	2410	1171	757	806	1016	3876	3466
Grand Total 1903, Nov. 1	3477	4146	1068	4557	3438	6013	3239	1614	1260	694	1319	3926	3550	1540	2513	2177	2740	1688	2644	...	1434	1370	2207	1309	1037	613	761	765	3221	2990
Extension and Similar Courses	638	3182	...	3644	597	1100	...	242	...	...	1185	235	1546	152	902	1676	...	227	379	411	...	...	...	757	117	...	319	...	2907	...
Officers	525	337	261	907	725	731	737	109	275	208	200	537	465	305	354	425	434	291	564	290	217	218	280	...	313	101	203	252	633	571

Note.—The grand totals of the University of Minnesota prior to 1912 are inclusive of "extension and similar students," which were listed separately in 1912 and 1913, hence the apparent decrease.

* Includes schools of mines, engineering, chemistry and related subjects.

† Included elsewhere.

‡ 1,220 students in attendance on summer courses.

women; Wisconsin, with 828 men and 776 women; Minnesota, with 639 men and 882 women; Texas, with 811 men and 709 women; Columbia, with 841 men and 623 women; Yale, with 1,402 men; Nebraska, with 541 men and 733 women, and Princeton, with 1,267 men.

In agriculture, Cornell leads with 1,354 students, being followed by Wisconsin with 968, Ohio State with 889, and Illinois with 792. In architecture Illinois with 351 is followed by Pennsylvania with 259, and Columbia and Cornell with 143 each. Washington University, with 305 art students, leads in that field, being followed by Syracuse with 178; while New York University continues to lead in commerce with 2,013 students, being followed by Pennsylvania with 1,430, Northwestern with 567, Wisconsin with 374, Illinois with 282, and California with 280. The largest dental school is at Pennsylvania, where 589 students are enrolled, as compared with 566 at Northwestern, 282 at Michigan, and 268 at Minnesota. Northwestern has the largest divinity school, enrolling 233 students, as against 125 at Chicago, 100 at Yale and 56 at Harvard; these are the only universities in the list that maintain schools of theology.

Syracuse has 220 students of forestry, Ohio State 65, Minnesota 41, Nebraska 36, and Yale 32; at California, Illinois, Michigan and Missouri, the forestry students are counted in with other departments. Columbia has a long lead in the number of non-professional graduate students, there being no less than 1,496 students enrolled in its faculties of political science, philosophy and pure science. Columbia is followed by Harvard with 489 students, Chicago with 480, Pennsylvania with 438, and California with 408. Columbia has the largest school of journalism, enrolling 106 students as compared with Wisconsin's 91, Indiana's 73, and Missouri's 64. The largest law school is at New York University, where 771 students are registered in this subject; Harvard follows with 695 students, Michigan with 553, and Columbia with 450. In medicine Illinois leads with 445, being followed by New York University with 432, Tulane with 399, Johns Hopkins with 368, Michigan with 353, Columbia with 341, and Harvard with 306. Syracuse has the largest number of music students, namely, 925, there being 407 at Northwestern and 130 at Kansas. The Teachers College of Columbia University is by far the largest school of education connected with any of the institutions in the list. It has an enrollment this fall of no less than 1670 students, as against 699 at Pennsylvania, 443 at Texas, 421 at Pittsburgh and 420 at New York University. Columbia also has by far the largest school of pharmacy, enrolling 441 students, as against 255 at Illinois, 209 at Pittsburgh, and 135 at Northwestern. As for the scientific schools, Cornell continues to maintain its lead in this branch, enrolling 1,343 students, as against Michigan's 1,282, Yale's 1,133, Illinois's 1,001, California's 828, Ohio State's 811, Wisconsin's 775, Columbia's 665, Pennsylvania's 657, and Minnesota's 638. In veterinary medicine Ohio State leads with 163, being followed by Pennsylvania with 125, and Cornell with 122. All of the above figures for individual faculties are exclusive of the summer-session attendance. The largest summer session in 1913 was at Columbia University, where 4,539 students were enrolled, as against 3,771 at Chicago, 2,363 at California, 2,120 at Wisconsin, 1,408 at Michigan, 1,392 at Cornell, 1,163 at Tulane, and 1,084 at Indiana.

The largest number of officers is found at Columbia, where the staff of teaching and administrative officers consists of 907 mem-

bers, as against 737 at Illinois, 731 at Harvard, 725 at Cornell, and 633 at Wisconsin.

The 638 students enrolled at the University of California in extension and similar courses are distributed as follows: San Francisco Institute of Art 201, Wilmerding School of Industrial Arts 155, University Farm School 187, and short courses in agriculture 95.

The 3,182 students listed under extension and similar courses at the University of Chicago are enrolled in correspondence study courses. The 808 students mentioned under other courses are enrolled in regular university courses given primarily for teachers which meet on Saturday mornings and late in the afternoons.

Among the 84 students of medicine enrolled at the University of Cincinnati, 23 are registered in clinics and pathological work. The 486 students mentioned under other courses are enrolled in evening academic courses.

Of the 3,644 students enrolled under extension and similar courses at Columbia University, 1,152 are students in special classes at Teachers College and 2,492 are students in extension courses.

Of the 1,120 students registered at Cornell University under arts and sciences, 950 are candidates for the degree of A.B. and 170 for the degree of B.Chem. Of the total number of 4,760 students enrolled in the fall, 4,273 are men and 487 women. The students mentioned under extension and similar courses were enrolled in the short winter course in agriculture for 1912-13.

The 113 students mentioned under commerce at Harvard University are enrolled in the graduate school of business administration. Of the 61 students in architecture, 23 are enrolled in landscape architecture, while the 76 students mentioned under scientific schools are enrolled in the graduate school of applied science. Only one department, forestry, which is a part of the graduate school of applied science, shows a marked decrease, the enrollment having dropped from 18 to 9. This may possibly be accounted for by the fact that this year for the first time students were expected to register in July, instead of in September, and this may not have been sufficiently widely known. Also, the course has been changed somewhat, including general work in the first year and special work in the second year. In landscape architecture, which is also in the graduate school of applied science, there has been a marked increase, 23 students being enrolled this year, as opposed to 15 in 1912, and 7 in 1911.

Of the 350 students given under other courses at the University of Illinois, 310 are enrolled in household science and 40 in library economy. In Chicago, the departments of medicine and dentistry have been reopened with higher entrance requirements—hence the material loss in the registration in these schools as compared with the registration of two years ago.

The students mentioned under scientific schools at Indiana University are pursuing courses in chemistry, provision for technical work being made at Purdue University.

The 86 students given under other courses at the State University of Iowa are enrolled in courses for nurses.

At Johns Hopkins, 169 men and 39 women are enrolled in the graduate school, and 15 are taking graduate work in engineering. Of the 368 students given under medicine, 8 are physicians attending special courses.

Of the 353 students given under medicine at the University of Michigan, 75 are enrolled in the homeopathic medical college.

At the University of Minnesota, agricul-

ture, inclusive of the home economic division, shows a steady growth. The apparent increase in the graduate school is explained by regulations concerning registration rather than by an influx of advanced students. However, impetus has been given to this department by the appointment of Professor Guy S. Ford, formerly of the University of Illinois, as dean. The law school is feeling the full effect of the requirement of two years of academic work for admission to regular courses, also the effect of discontinuing night classes. Many of the subjects heretofore offered by the law school in evening courses have been transferred to the extension department. Heretofore little emphasis has been given to music. This year marks the beginning of a regular four years' course in arts and music leading to the degree of bachelor of arts in music, consequently these students are listed separately this year for the first time. The requirements for admission are the same as for the college of science, literature and the arts. The college of engineering has secured F. E. Mann, of the University of Illinois, to take charge of the department of architecture, and the courses in architecture and architectural engineering have now been permanently established. The requirements for admission are the same as the engineering courses and the B.S. and appropriate professional degrees are granted at the close of four and five years, respectively. The reorganization of the extension division and the advent of Professor R. R. Price, formerly of Kansas University, as director of this department, explain the increased enrollment in this division.

The decrease in enrollment in the school of law at the University of Missouri is due to the fact that during this session all of the three classes in that school are based upon an admission requirement of two years of college work, while the third-year class of last year was admitted under the former requirement of four years of high school work. There is a decrease in the school of engineering due to a similar reason, but as there has been an increase in the school of mines, the total enrollment in technical schools shows a slight increase. It has been anticipated that a similar decrease would be manifested in the school of journalism. Notwithstanding the fact, however, that there is during the present session only one of the classes which entered under the former requirements as compared with two such classes during the session of 1912–13, the total enrollment in the school shows an increase.

At the University of Nebraska, there is but little change in registration this year as against 1912, the most apparent increase being in the school of agriculture, at the expense of the professional schools.

Every school in New York University with the exception of the veterinary college shows a marked increase. The increase in the college of arts and pure science is due largely to the transfer of the medical preparatory class from the collegiate division to the freshman class of the college.

Of the 296 students enrolled in other courses at Northwestern University, 172 are registered in the school of oratory and 124 are taking courses for nurses. There have been noteworthy increases in attendance in several of the schools of the university, especially in the college of engineering, the dental school, and the school of commerce. There is an increase in the college of liberal arts in spite of the increased tuition fees. The same increase in fees was put into effect in the college of engineering, but, nevertheless, the enrollment is the most encouraging in the history of the college, it being due to a consistent and dignified sys-

tem of publicity. In the dental school, the university is increasingly strict in administering entrance requirements, and yet the enrollment has increased at a phenomenal rate. The increase in the school of commerce is an evidence of the need of such work in a large city; these courses are given in the evening, and the registration is in great part made up of men who are in business during the day. In the statistics of November 1, 1912, the report showed 368 students enrolled in the law school; the figure should be 268.

The 280 students given by Ohio State University under other courses are enrolled in home economics. The 227 students in extension and similar courses represent the enrollment of 1912–13. The fall enrollment shows substantial increases in all colleges except the college of law, which is 13 short of the enrollment November 1, 1912. The largest gains in the colleges have been as follows: agriculture 188, engineering 109, arts 94, and education 37. The increase in the fall enrollment is 434. These increases are probably due to a revival of interest among the alumni of the university. Two years ago, under the able leadership of Mr. Ralph D. Mershon, of New York, the alumni and former students of the university were reorganized into a live association. Local organizations have been formed in all parts of the state and in all prominent cities of the country. A permanent secretary, who gives all of his time to alumni interests, has been employed. The annual observance of "Ohio State Day" by alumni and former students throughout the state and country has done much to bring the university into prominence in local communities. A new department of competitive and recreative athletics was created by the board of trustees last June. The director of athletics and the men associated with him have been given faculty rank. A limited amount of credit will be given for work in courses in the teaching of athletics. A new course in applied entomology, leading to the degree of bachelor of science in entomology, has been added to the curriculum. Two new combination courses have also been arranged, arts—agriculture and arts—home economics, making it possible for a student to receive two degrees in five years. The last General Assembly of Ohio authorized the establishment of an engineering experiment station at the university and the organization of a college of medicine. No definite action has been taken by the board of trustees. The General Assembly also authorized and directed the university to establish and organize a university extension division, for the purpose of carrying on educational extension and correspondence instruction throughout the state.

At the University of Pennsylvania, the 379 students listed under extension and similar courses are enrolled in courses at Wilkes Barre (185) and Scranton (194). The 9 students listed under other courses are enrolled in hygiene. The 699 students listed under pedagogy are enrolled in college courses for teachers. Nearly all departments share in the gains in enrollment, the most noticeable increase being in the Wharton school of finance and commerce, and in the evening school of accounts and finance. The school of architecture continues its advance in registration, the total this year being 259, or an increase of 43. The graduate school, with a total enrollment of 438, is 67 ahead of the preceding year. The law school, with a total enrollment of 381, is just 2 short of the figures of last year. The medical school is still feeling the effects of the raise in entrance requirements put into effect within the past few years. The enrollment of 283 shows a loss of 37. The dental school, with 589

students, has an increase of 80. Other departments show slight gains or losses which are negligible.

At the University of Pittsburgh, the 157 students listed under other courses are male candidates for degrees in economics. Of the 411 students given under extension and similar courses, 127 are taking teachers' courses without credit and 284 are enrolled in the evening school.

The students at Leland Stanford University listed under law and medicine and the graduate school are all included also under the college.

At Syracuse University, of the 233 students listed under separate courses, 50 are taking work in library economy; 275 students from the college of liberal arts are also taking work in education.

At Tulane University, 7 are enrolled in tropical medicine and hygiene and 22 are taking post-graduate medical work. The students mentioned under scientific schools are enrolled for engineering and sugar chemistry. The increase in numbers of the college of technology is due to changes made in the college, amounting practically to reorganization.

The 48 students listed under other courses at Washington University are in the school of social economy. The 319 students listed under extension and similar courses are taking Saturday courses for teachers and others in the college.

The 45 students listed under other courses at Western Reserve University are taking work in library economy. In Adelbert College, the college for women, the graduate school, the school of law and the library school, the annual tuition fee has been advanced from $100 to $125, and in the school of medicine from $125 to $150, these charges going into effect this year. The loss in enrollment in the school of law is due to the graduation of the last class received upon the non-graduate basis, all classes now being upon the college graduate basis. The change from the non-graduate to the graduate basis is seen to have taken effect with but a small loss in numbers. The loss in enrollment in the school of medicine is more apparent than real, the difference being caused largely by the recent yearly graduation of two classes,—Ohio Wesleyan University and Western Reserve University,—and the reception of one class on the Western Reserve University college graduate basis only.

Of the 45 students listed under other courses at the University of Wisconsin, 43 are enrolled in library economy and 2 are taking work in public health. The 40 students in pharmacy include 24 students in a two-year pharmacy course, for which four years of high school preparation is not required. A forest rangers' course consisting of 12 students began work at the university January 7, 1913. These students did not complete their field work until November 30.

The most considerable increase in enrollment at Yale University is in the college. The entering classes in the law and medical schools also show noticeable increases and indicate that the requirement of a college degree for admission to the law school and of two years of college work for admission to the medical school, adopted two years ago, is being appreciated by the best grade of students. The only noticeable falling off is in the graduate school. This is due exclusively to the new requirement of two years' work for the master of arts degree instead of one year, as in force at Yale prior to 1912 and still the custom at almost all the American universities.

RUDOLF TOMBO, JR.
COLUMBIA UNIVERSITY

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND HARVARD UNIVERSITY[1]

In this agreement, "the institute" means the Massachusetts Institute of Technology, and "the university" means Harvard University. It is understood that any action of the president and fellows of Harvard College shall require the consent of the board of overseers wherever such consent is necessary under the laws governing the university.

I. The university and the institute shall be unaffected in name, organization, title to and rights over property, or in any other way not specifically mentioned in this agreement.

II. The university and the institute shall cooperate in the conduct of courses leading to degrees in mechanical, electrical, civil and sanitary engineering, mining and metallurgy, and in the promotion of research in those branches of applied science. The courses and research shall be conducted in accordance with the provisions of this agreement and on the site in Cambridge recently acquired by the institute bordering on Massachusetts Avenue and the Charles River Embankment or on any other site that may be agreed upon should future conditions render an extension or change of site desirable.

III. Subject to the reservations hereinafter set forth the university shall devote to the purposes referred to in Section II. the net income of all funds that are credited on its books to the Lawrence Scientific School; also the use of all machinery, instruments, and equipment that are suited to these purposes and that the university does not in its opinion need more urgently for other purposes; also not less than three fifths of the net income of the Gordon McKay Endowment; also the income of all property that it may acquire hereafter for the promotion of education or research in the branches of applied science referred to in Section II.; also such further sums as it may from time to time feel able to contribute.

IV. Subject to the reservations hereinafter set forth, the institute shall devote to the purposes referred to in Section II. all funds, or the income of all funds, that it now holds or hereafter acquires for the promotion of education or research in the branches of applied science mentioned in that section, and in addition to this as much of the funds, or income of funds, that it holds for general purposes as is not in its opinion more urgently required for other purposes.

V. Students' fees for courses in the branches of applied science mentioned in Section II., shall be devoted to the purposes referred to in that section. These fees shall for the first ten years be deemed to be contributed by the two institutions in the proportion of the numbers of the students following these courses in the institute and in the university's graduate schools of applied science, respectively, during the year 1913–14. At the end of ten years a different arrangement shall be made, if, in the opinion of the two corporations, it appears to be more equitable. The fees of students pursuing courses in the subjects referred to in Section II. in the university's graduate schools of applied science at the time when this agreement is adopted shall be unaffected by any change brought about by this agreement. For all other students the amount of the fees for complete courses leading to those degrees of the institute and of the university that are granted through the operation of this agreement shall be $250 per annum until changed by agreement between the two corporations. The amount of fees for partial courses and for research shall be determined as may be agreed upon from time to time.

VI. The funds available for education and research in the branches of applied science referred to in Section II. shall be expended through the bursary of the institute in the payment of salaries, the maintenance of scholarships, the care of grounds, and the erection and maintenance of buildings and equipment or otherwise as may be agreed upon from time to time, it being expressly provided that all proposed appropriations shall be approved by the corporation that supplies the funds, and that buildings shall be erected only

[1] Agreement ratified by the corporations of both institutions on January 6.

from the share of the funds supplied by the institute.

VII. All members of the instructing staff in the departments of mechanical, electrical, civil and sanitary engineering, mining and metallurgy, who give instruction in courses leading to the degrees both of the university and of the institute, shall be appointed and removed by the corporation that pays their salaries after consultation with the other corporation.

VIII. All students registered at the institute in the various numbered professional courses covered by Section II. that lead to degrees of the university shall be deemed to be prospective candidates for such degrees unless they signify a contrary intention, and shall be entitled to the same rights and privileges as students in the professional schools of the university.

IX. The president or acting president of the institute shall be the executive head for all the work carried on under this agreement. As an evidence of his responsibility in directing it he shall make an annual report to both corporations. When any future president or acting president is to be selected, the president or acting president of the university shall be invited to sit with the committee that recommends the appointment of a president or acting president to the corporation of the institute.

X. As soon as this agreement goes into effect, the faculty of the institute shall be enlarged by the addition thereto of the professors, associate professors and assistant professors of mechanical, electrical, civil and sanitary engineering, mining and metallurgy, in the university's schools of applied science. These persons shall acquire the titles and privileges of the same rank in the institute while retaining their titles and privileges in Harvard University, and the terms and conditions of their employment and their salaries shall be unaffected by the change. The professors, associate professors and assistant professors of the institute in the departments of mechanical, electrical, civil and sanitary engineering, mining and metallurgy, shall acquire the titles and privileges of the same rank in Harvard University while retaining their titles and privileges in the institute, and the terms and conditions of their employment and their salaries shall be unaffected by the change. All professors, associate professors and assistant professors appointed under the operation of Section VII. shall have the titles and privileges of professors of the university and of the institute, including the right to benefit from the pension system of both institutions.

Additions to the faculty of the institute shall be made by the appointment of professors, associate professors or assistant professors, under the operation of Section VII., or by the corporation of the institute for other purposes. The faculty constituted as indicated above shall, subject to such directions as may be given by the corporation of the institute, prescribe the courses and conditions of entrance thereto leading to all degrees granted by the institute. The same faculty shall, subject to such directions as may be given by the corporation of the university, prescribe the courses and conditions of entrance thereto leading to all degrees granted by the university under the operation of this agreement.

XI. Degrees shall be conferred by the institute and by the university acting separately on the recommendation of the faculty referred to in Section X.

XII. It is expressly provided that, as regards the funds and property of the university and of the institute respectively referred to in Sections III. and IV., this agreement shall be subject to any special terms and requirements upon which such funds and property may be held; and any property or funds that may be held at any time by either corporation under such terms and restrictions as would prevent their use precisely as is indicated in this agreement, shall, nevertheless, be used by the two corporations respectively for the support, benefit or encouragement of a cooperative effort in the field of education and research in engineering and mining in such manner as may be permissible or in accordance with the trusts upon which they may be held.

XIII. Whereas, doubts might arise as to

the legal effect of an omission from this agreement of any provision for its termination, it is hereby provided that the agreement may be terminated either by the university or by the institute, but that no termination shall be made except upon notice from one party to the other of at least five years unless a shorter time be mutually agreed upon.

XIV. This agreement shall take effect when finally adopted and approved by the corporation and board of overseers of the university and the corporation of the institute; and the cooperation referred to in Section II. shall begin when the institute is ready to open courses in engineering and mining on the site in Cambridge mentioned in that section.

STATEMENT BY PRESIDENT LOWELL

Friends of Harvard University and the Massachusetts Institute of Technology—and they have many friends in common—have long deplored the rivalry of two schools of engineering competing on opposite sides of a river. The disadvantages have been made even more evident by the decision of the institute to cross the Charles; but the difficulty of making an arrangement satisfactory to both parties has hitherto been very great, and in fact the obstacles to a combination between rival institutions supported by and serving the same community have been one of the grave defects of higher education in America. This difficulty seems at last to have been overcome here by a plan for cooperation in the conduct of one school of engineering and mining. The plan is favorable to both institutions. Both gain thereby. Which gains the most can probably not be determined, and certainly has not been computed, for the leading motive with the authors of the agreement has lain in another plane. Both institutions exist for the promotion of instruction and research. Each is a means to an end larger than itself, the welfare of the community as a whole; and that both acting in concert can further this end better than either working alone can not be doubted. By the combination of resources and momentum a school ought to be maintained unequalled on this continent and perhaps in the old world.

A. Lawrence Lowell

STATEMENT BY PRESIDENT MACLAURIN

The advantages of cooperation between the institute and Harvard have long been the subject of discussion. With reference to the present plan of cooperation, I beg to make the following statements:

1. The Honorable Richard Olney, in a carefully considered legal opinion, says "Cooperation between educational institutions for a legitimate purpose common to both is certainly not illegal and in this case wholly desirable. The 'agreement' seems to me to spell cooperation and nothing more, involves no merger of corporations or their property interests, and can be carried into effect without violation of charters or of the trusts upon which funds are held."

2. Its adoption by the corporation is unanimously recommended by the executive committee.

3. It is approved by each of the last five presidents of the Alumni Association, and by the president-elect. The president of the Alumni Association, Mr. Frederic H. Fay, writes: "I heartily commend this effort on your part, and I believe that when it is found that an agreement, such as you have proposed, can be carried out to the satisfaction of the authorities of both institutions, you will find that you have the great body of Tech Alumni behind you, and that you will have added to the prestige, and usefulness and strength of the institute."

4. It is approved by all the heads of the institute's departments that are directly affected and by all the other senior members of the faculty who have been consulted with reference to it.

5. It leaves the institute so entirely independent that it can appoint any officer or instructor that it pleases, it can appropriate its funds as it pleases, and it can make any regulations that it pleases with reference to the courses leading to its degree.

I believe that the adoption of this agreement is a forward step of very great import to the

future of education in this country. Incidentally, it would be of great advantage to each of the cooperating institutions, but it would be especially significant in the emphasis that it would give to the fact, so often overlooked, that educational institutions do not exist for themselves and that their sole duty is to make the best provision that can possibly be made for those who are rising to manhood and for their successors. Under the scheme of cooperation here proposed, it would be possible to maintain a much stronger school of applied science than either institution alone could furnish, and it would be possible to keep that school practically unrivalled in America—and indeed, in the world.

SCIENTIFIC NOTES AND NEWS

DR. BENJAMIN OSGOOD PEIRCE, since 1888 Hollis professor of mathematics and natural philosophy in Harvard University, died from disease of the heart at his home in Cambridge on January 14.

DR. HERMAN M. BIGGS has been appointed by Governor Glynn to be commissioner of health for the state of New York.

DR. ERNEST RUTHERFORD, Langworthy professor of physics in the University of Manchester, has been made a knight.

IN the Academy of Sciences of St. Petersburg, Sir William Ramsay has been advanced from a corresponding to an honorary member.

AT the annual meeting of the Federation of American Societies for Experimental Biology, an organization which includes the Physiological Society, the Society of Biological Chemistry and the Society for Pharmacological and Experimental Therapeutics, held in Philadelphia, the following officers were elected: *President,* Dr. Graham Lusk, New York City; *Vice-president,* Dr. Carl Alsberg, Washington, D. C.; *Secretary,* Dr. P. A. Shaffer, St. Louis; *Treasurer,* Dr. D. D. Van Slyke, New York City, and councilors, Professor J. J. Abel, Baltimore, and Professor A. B. Macallum, New York, and Dr. T. B. Osborne, New Haven, Conn.

PROFESSOR W. B. CANNON, of Harvard University, was elected president of the American Physiological Society at the meeting in Philadelphia.

AT the thirtieth session of the American Association of Anatomists held in Philadelphia at the University of Pennsylvania the following officers were elected: *President,* Professor G. Carl Huber, University of Michigan; *Vice-president,* Professor Frederic T. Lewis, Harvard Medical School; *Secretary-treasurer,* Professor Charles R. Stockard, Cornell Medical College.

AT the meeting of the American Phytopathological Society recently held at Atlanta the following officers were elected: *President,* Dr. Haven Metcalf, Washington, D. C.; *Vice-president,* Dr. Frank D. Kern, State College, Pa.; *Counsellor,* Professor H. R. Fulton, West Raleigh, N. C.

A DINNER in honor of Dr. Livingston Farrand, professor of anthropology in Columbia University, who has accepted the presidency of the University of Colorado, was held by his colleagues at the Faculty Club, Columbia University, on January 13.

THE following new appointments of members of the gardening staff at Kew are quoted in *Nature* from the *Kew Bulletin:* Mr. G. S. Crouch, to be assistant director of horticulture in the Egyptian department of agriculture; Mr. T. H. Parsons, to be curator of the Royal Botanic Gardens, Peradeniya, Ceylon, in succession to Mr. H. F. Macmillan, who has been appointed superintendent of horticulture in the department of agriculture, Ceylon; Mr. C. E. F. Allen, to be curator of the Botanic Garden, Port Darwin, Northern Territory, South Australia, in succession to Mr. N. Holtze, deceased.

MRS. AGNES CHASE, assistant in systematic agrostology, U. S. Department of Agriculture, has returned from Porto Rico where she has been collecting and studying grasses for about two months. Of the 123 species of grasses known from the island she obtained all but three, and about 40 additional species. *Arthrostylidium sarmentosum* Pilger, a climbing

bamboo, known only in the sterile condition, was obtained in flower.

AN alumni chapter of the Sigma Xi has been planned in Washington, D. C., which will be known as the "D. C." Chapter. An organizing committee consisting of Marcus Benjamin (Columbia), *Chairman;* M. W. Lyon (Brown), *Secretary;* Paul Bartsch (Iowa), B. W. Everman (Indiana), Edmond Heller (Stanford), L. O. Howard (Cornell), F. J. Katz (Chicago), W. R. Maxon (Syracuse), T. S. Palmer (California), J. E. Pogue (Yale) and B. H. Ransom (Nebraska) are about to apply for a charter. As there are over 200 members in Washington it is expected that a large and flourishing chapter will be formed.

THE Norman W. Harris Lectures for 1913–1914 will be delivered by Dr. Edwin Grant Conklin, professor of zoology at Princeton University, on the subject, "Heredity and Environment in the Development of Men," February 9 to 14 inclusive, Northwestern University, Evanston.

AT the annual meeting of the Washington Academy of Sciences held at the Cosmos Club on January 15, the retiring president, Dr. O. H. Tittmann, delivered an address on "Our Northern Boundaries."

PROFESSOR EDWARD KASNER, of Columbia University, on January 17 gave a lecture at Princeton University on "Elements of Infinite Order and the Geometry of Divergent Power Series."

AT an open meeting of the Sigma Xi Society at Case School of Applied Science, Cleveland, Ohio, on January 14, Dr. O. P. Hay, research associate of the Carnegie Institution of Washington, D. C., lectured on "The Ice Age of North America and its Remarkable Animals."

THE first of a series of lectures on practical conservation and industrial questions, given under the auspices of the Ohio State University for the benefit of citizens of the state, was delivered January 8 by Professor C. E. Sherman, of the department of civil engineering. His theme was the regulation of streams, with special reference to floods.

ON January 6 Associate Professor Frederick Starr, of the department of sociology and anthropology in the University of Chicago, begins a course of five illustrated lectures on the general subject of "Japan: The Land of the Rising Sun" at the Abraham Lincoln Center of the University Lecture Association in Chicago. The subjects of the individual lectures are as follows: "The Life of the Japanese," "Japanese Religion," "The Hairy Ainu of Japan," "Korea: The Land of the Morning Calm," and "Far Eastern Questions."

PROFESSOR ALBION WOODBURY SMALL, head of the department of sociology and anthropology in the University of Chicago, delivered on December 27, at the eighth annual meeting of the American Sociological Society in Minneapolis, his address as the retiring president of the society. The address, which was on "Problems of Social Assimilation," was given at a joint meeting of the American Sociological Society and the American Economic Association.

MR. W. POPPLEWELL BLOXAM, formerly professor of chemistry in Presidency College, Madras, and the author of papers on the production and chemistry of indigo, died on December 26, aged fifty-three years.

DR. GEORGE WILLIAM PECKHAM, librarian of the Milwaukee Public Library, known for his important contributions to entomology, died on January 11, aged sixty-eight years.

EDMUND B. HUEY, PH.D., died in Connell, Washington, on December 30, 1913. Dr. Huey had been in the west for a year trying to regain his health. He had previously been associated with Dr. Adolf Meyer, at the Johns Hopkins Hospital. He was the author of a book on "The Psychology of Reading" and another on "Mentally Defective Children," and was one of the foremost leaders in the more recent study of mentally defective children. He spent a year studying defective children at the State Home for the Feeble-minded at Lincoln, Ill., and had previous to this spent two years with Janet in Paris. He was preparing a book on clinical psychology, but about six months before his death the notes and what

manuscript he had prepared, the accumulation of perhaps ten years, were completely destroyed by fire.

As the result of infection by glanders bacilli while working in the laboratory, Mr. A. M. Jansen, instructor in the veterinary college of Ohio State University, died on January 4.

THE United States Geological Survey is in receipt of a cablegram from St. Petersburg in which "the Geological Survey, of Russia, announces with profound grief the unexpected death of its director, Theodosie Tchernycheff, in the fifty-seventh year of his life."

A MEMORIAL fund raised by the friends of the late Humphrey Owen Jones, F.R.S., fellow of Clare College, who, with his wife, was killed in the Alps in August, 1912, has been gratefully accepted by the university, and a Humphrey Owen Jones lectureship in physical chemistry has been established.

THE U. S. Civil Service Commission announces a competitive examination for research chemist, to fill two vacancies in this position in the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., at salaries of $1,800 a year.

THE completion of the 30-inch photographic refractor of the Allegheny Observatory has been long delayed by the difficulty of manufacturing suitable glass disks. These have now been delivered by Schott and Co., of Jena, Germany, and it is expected that the telescope will be in use early next fall.

AT a recent meeting of the board of trustees of the University of Illinois, Mr. R. Y. Williams was appointed director of the miners' and mechanics' institutes, which are to be established under the direction of the department of mining engineering. Authority for the establishment of these institutes was granted by an act of the state legislature in 1911, but no appropriation was made to carry out the authorization until the latter part of the recent sesion of the legislature, at which time an appropriation of $15,000 per annum was made. The purpose of the miners' and mechanics' institutes is somewhat similar to that of the farmers' institutes, but their specific purpose is to assist men who are preparing themselves to pass the tests required by the state before they can hold official positions about the mines. Mr. Williams graduated from Princeton University in 1901.

IT is stated in the *British Medical Journal* that Dr. L. W. Sambon, who left England in August last to investigate pellagra in the West Indies, returned to London at the beginning of January. By invitation he first proceeded to the United States of America, and in Spartanburg, Columbia and Charleston he met several of the men who have recently devoted themselves to the study of pellagra, and delivered addresses before medical societies in these cities. Dr. Sambon found that in the United States the interest in the disease was very keen, owing no doubt to the evidences of the existence of pellagra to a serious extent in many parts of the country. As is well known, Dr. Sambon's opinion is that pellagra is not due to the consumption of maize, whether diseased or sound, but that it is caused by an infection brought about most probably by a fly. His investigations in southern and eastern Europe suggested that the intermediary was a simulium, an insect closely allied to the group represented by the sandfly. In the United States Dr. Sambon found many men ready to accept this hypothesis, and was greatly impressed with the work which was being carried out by the Thompson-MacFadden Pellagra Commission in South Carolina. After leaving the North American continent he proceeded to the West Indies, where he visited Jamaica, Antigua, Barbados, Trinidad, Grenada, St. Vincent and other islands. In the hospitals, asylumns and rural districts he met with many cases of pellagra, and proved the existence of the disease in several areas in which its presence had previously been unknown. Dr. Sambon also visited British Guiana, and found pellagra along the coast from the Demerara to the Berbice rivers. In part of his trip Dr. Sambon was accompanied by Captain Siler, U. S. Army, chief of the American Pellagra Commission, and by Mr. Jennings, of the Entomological Bureau, Washington, D. C.

Seventy-five per cent. of a highly valuable fertilizing material in the form of tankage and blood from the country slaughter of food animals is being wasted throughout the country districts, according to a recent bulletin of the Department of Agriculture. Tankage, a product of slaughter houses consisting of such waste material as bones, horns, hoofs, hair, etc., contains a large percentage of nitrogen and other products used in commercial fertilizer and in the larger packing houses is carefully saved. In country killing, however, only 25 per cent. of the tankage and blood are saved for fertilizer. The nitrogen content of tankage is said to vary from 5 to 8 per cent. and its phosphoric acid content between 5 and 12 per cent. Dried blood is perhaps the richest in nitrogen of all the organic materials used in the fertilizing industries. Unadulterated blood when quite dry contains 14 per cent. of nitrogen, but as obtained on the market its content varies from 9 to 13 per cent. From the figures estimated by the Bureau of Animal Industry, Department of Agriculture, as representing the total slaughter of cattle, calves, swine, and sheep in the United States, in 1912, it has been calculated that if all the materials rendered available by this slaughter had been saved and converted into tankage and dried blood, they would have produced 222,535 tons of tankage and 79,794 tons of dried blood. The introduction of a cooperative system among American farmers undoubtedly would result in an increased utilization of blood and tankage for fertilizing purposes. In Denmark country killing is being practised on a cooperative basis in small country abattoirs, and the blood is carefully preserved.

UNIVERSITY AND EDUCATIONAL NEWS

A new art building to cost $125,000 is now guaranteed for Oberlin College. The names of the donors are at their request withheld.

Mr. F. W. Bradley has offered a gift of $1,000 a year for at least ten years to endow a loan fund for students in the college of mining of the University of California. Both principal and income of the gift are to be available for these loans.

Harvard University has received the sum of $7,500 with which to establish a scholarship in memory of the late Francis Hardon Burr, '09. This fund is to be known as the Francis H. Burr 1909 Fund, and the yearly income therefrom is to be used in helping deserving undergraduates who combine as nearly as possible Burr's remarkable qualities of character, leadership and athletic ability. The fund was raised principally from the members of Burr's class, but some of his older friends also contributed.

By the will of the late Miss Emily M. Easton £10,000 are bequeathed to the Durham College of Medicine, Newcastle, and £5,000 to Armstrong College.

The dedication at the winter convocation of the University of Chicago of the new addition to the Ryerson Physical Laboratory marks a great increase in the research facilities of the university in the field of physics. The new addition is connected with the original building by corridors and consists of a basement and three floors. It contains the liquid air and refrigerating plants, the dynamos and motors, the machine and instrument shops, and the switchboard for distributing electric currents of all kinds to all parts of both buildings. It has besides two large student laboratories, a lecture room and four research rooms. The old Ryerson Laboratory has been renewed by the installation of a modern electric light and power system of unusual completeness, by the insertion of new steel-concrete floors in all the ground-floor rooms, and by the remodeling of the entire basement into a series of special research rooms, of great value where freedom from vibration and constancy of temperature are required.

The associates of Radcliffe College have elected Miss Bertha May Boody to succeed Miss Mary Coes as dean of the college. Miss Boody is a native of Brookline and received the A.B. degree from Radcliffe in 1899 and the A.M. degree from Columbia in 1912. She has

studied for one winter in the American School for Classical Studies in Rome, and for one summer in the University of Cambridge, England.

PROFESSOR WALTER MULFORD, of Cornell University, has been appointed head of the new department of forestry in the University of California. His duties will begin with August 1 next. Since there are 29,000,000 acres of national forest in California, besides vast areas of forest privately owned, the subject is one of great importance there. Dr. Patrick Beveridge Kennedy has been appointed assistant professor of agronomy. Dr. Calvin O. Esterly has been appointed as a biologist in the Scripps Institution for Biological Research at La Jolla.

MR. J. J. GALLOWAY, Ph.D. (Indiana), has been appointed instructor in geology at Indiana University.

MR. HALBERT P. BYBEE, M.A. (Indiana), has been appointed instructor in geology at the University of Texas.

MR. J. C. JOHNSON has been appointed to the chair of general biology, botany and zoology, at Auckland University College, in succession to Professor A. P. W. Thomas.

DISCUSSION AND CORRESPONDENCE

COLUMBIUM VERSUS NIOBIUM

AT a meeting of the Council of the International Association of Chemical Societies in Brussels, last September, a committee on inorganic nomenclature, among other recommendations, endorsed the name and symbol "niobium" and "Nb," for the element which was originally named columbium. As this recommendation is historically erroneous, a brief statement of the facts appears to be desirable.

In 1801, Hatchett, an English chemist, analyzed a strange American mineral, and in it found a new metallic acid; the oxide of an element which he named columbium. A year later, Ekeberg, in Sweden, analyzed a similar mineral from Finland, and discovered another element, which he called tantalum. Wollaston, in 1809, undertook a new investigation of these elements, and concluded that they were identical; a conclusion which, if it were true, would have involved the rejection of the later name, and the retention of the earlier columbium. The accepted rules of scientific nomenclature make this point clear.

For more than forty years after Hatchett's discovery, both names were in current use; for although Wollaston's views were accepted by many chemists, there were others unconvinced. In 1844, however, Heinrich Rose after an elaborate study of columbite and tantalite from many localities, announced the discovery of two new elements in them, niobium and pelopium. The latter supposed element was afterwards found to be non-existent, but the niobium was merely the old columbium under a new name. That name in some mysterious manner was substituted by the German chemists for the original, appropriate name, and has been in general use in Europe ever since. In America, the name columbium has been generally preferred, and was formally endorsed by the Chemical Section of the American Association for the Advancement of Science more than twenty years ago. In England, also, columbium is much used, as, for example, in Roscoe and Schorlemmer's "Treatise on Chemistry," Thorpe's "Dictionary of Applied Chemistry," and the new edition of the Encyclopedia Britannica.

The foundation of Rose's error seems to have been an uncritical acceptance of Wollaston's views; for he speaks of all the minerals he studied as tantalite. He also, at least in his original memoir, claims that the atomic weight of niobium is greater than that of tantalum, and here he was obviously wrong.

In short, the name columbium has more than forty years priority, and during that interval was accepted by many chemists, and was more or less in current use. To employ the name niobium is not only unhistorical, but it is also unfair to the original discoverer, meaningless, and without any justification whatever. Furthermore, it injures the splendid reputation of Rose, for it perpetuates and emphasizes one of his few errors. The recom-

mendation of the committee above mentioned should not be accepted, for it is opposed to the established rules of priority.

F. W. Clarke

THE CYTOLOGICAL TIME OF MUTATION IN TOBACCO

In the current volume of Science, p. 35, Hayes and Beinhart after describing the origin of a many-leaved variety of Cuban tobacco by mutation say:

This mutation must have taken place after fertilization, *i. e.*, after the union of the male and female reproductive cells. If the mutation had taken place in either the male or female cell before fertilization, the mutant would have been a first generation hybrid, and would have given a variable progeny the following season.

Is it not equally probable that the mutation occurred in an egg-cell which then developed without fertilization? Parthenogenesis is known to occur in tobacco, and mutation in a growing or immature germ-cell seems inherently more probable than in a fully formed and fertilized one. Perhaps the behavior of the additional mutants obtained in 1913 will throw light on the matter.

W. E. Castle

Bussey Institution,
January 2, 1913

SCIENTIFIC BOOKS

Analytical Mechanics. By Haroutune M. Dadourian, M.A., Ph.D., Instructor of Physics in the Sheffield Scientific School of Yale University. D. Van Nostrand Company. Price $3.00.

In his preface, the author states that his "work is based upon a course of lectures and recitations which the author has given, during the last few years, to the junior class of the Electrical Engineering Department of the Sheffield Scientific School." We expect this book to contain, therefore, several topics of special interest to students of electricity. We find a chapter devoted to "Fields of Force and Newtonian Potential," one to "Periodic Motion," one to "Energy" and one to "Work." But, as the author states, "In order to make the book suitable for the purposes of more than one class of students more special topics are discussed than any one class will probably take up. But these are so arranged as to permit the omission of one or more without breaking the logical continuity of the subject."

The author himself is a physicist, and perhaps he intends this book to be suitable for classes in physics. The book seems to be written from the standpoint of the physicist rather than from the standpoint of the engineer. If this book is intended for the students of civil and mechanical engineering, then it must be said it has no advantage over the number of books already in the field. I doubt if it is even as suitable.

Judging from the recent discussions concerning the teaching of mathematics and mechanics, it seems that the successful book has not yet been written. Possibly the book everybody is looking for must be written on a new plan. To say that an author deviates from the generally acknowledged plan need not be a criticism of his book. Dr. Dadourian makes his volume unique in several ways, but I doubt if it will stand the test.

In the first place, he seems to avoid the graphical treatment. The modern tendency seems to be to emphasize this phase of the subject.

The question of "units" is always a source of contention between the physicist and the engineer. The absolute system of units is certainly the most logical. To the engineer, however, it is not a question of logic, but of adaptability.

Another departure from the usual mode of procedure in modern elementary text-books in mechanics is the extent to which he makes use of "vector addition." The first chapter is devoted to the subject of the "addition and resolution of vectors." On page 10 he gives the analytical expression for the resultant of any number of vectors, and the resolution of a vector into its three rectangular components. This section is made the basis of his whole book so far as the composition and resolution of vector quantities (forces, moments, couples, etc.) are concerned. All he needs to say is,

that a couple (for instance) is a vector and the desired equations follow at once. If economy of space means "economy of thought" then the author has made his book very simple indeed. To prove the equivalence of couples it is only necessary to state: "Two couples are equal when the vectors which represent their torques are equal in magnitude and have the same direction." This follows at once from his definition of a vector.

He states in his preface "that a subject like mechanics should start with a few simple laws and the entire structure of the science should be based upon them. In the present work the following law is made the basis of the entire subject:

"*To every action there is an equal and opposite reaction, or, the sum of all the actions to which a body or a part of a body is subject at any instant vanishes.*" He further states that thus the "fundamental principle of mechanics is put in the form of a single law, which is equivalent to Newton's laws of motion and which has the advantages of the point of view involved in D'Alembert's principle."

Here is a unique departure for an elementary book. Does he mean to say that this law, whatever it may mean, is the only assumption he will make and that Newton's laws of motion as usually given will not be made use of? If he does, he completely fails. On page 16, he introduces the conception of "force" as an "action," and without any hesitation applies vector addition to a system of forces. What is he doing here, but assuming the "parallelogram of forces" in its most general form. On page 102 he assumes that a force is proportional to the acceleration produced. This assumes Newton's second law of motion. In fact he makes more assumptions than are usually made in elementary text-books of mechanics.

What about the law itself? The first part of the law is clear. "To every action there is an equal and opposite reaction" is nothing but Newton's third law of motion. The word "or" leads us to think that the second part means the same thing as the first part. On page 15 he states that "The fundamental law of mechanics is known as the law of *action* and *reaction*." He then states Newton's third law and gives the following illustration. "Let us apply this law to the interaction between a book and the hand in which you hold it. Your hand presses upward upon the book in order to keep it from falling, while the book presses downward upon your hand. The law states that the action of your hand equals the reaction of the book and is in the opposite direction. The book reacts upon your hand because the earth attracts it. When your hand and the earth are the only bodies which act upon the book, the action of your hand equals and is opposite to the action of the earth. In other words, the sum of the two actions is nil. Generalizing from this simple illustration, we can put the law into the following form:

"To every action there is an equal and opposite reaction, or the sum of all the actions to which a body or a part of a body is subject at any instant vanishes."

Now does he mean to say that the pressure of the hand on the book and the force of gravity acting on the book are equal because they are action and reaction? If he does he errs. *They are not action and reaction* and *are equal only in case equilibrium exists*. He has said nothing about equilibrium and if he does not mean this then what does he mean?

On page 100 he takes up the subject of "motion of a particle." Here he says that "we must extend the meaning of the term *reaction* so as to include a form of reaction which is known as *kinetic reaction*. In his illustration we see that by *kinetic reaction* he means the so-called *force of inertia*. We also see that he considers kinetic reaction as a real force. To this, serious objections can be raised. The meaning of the second part now becomes clear. It is simply *D'Alembert's Principle*—"The impressed forces together with the reversed effective forces form a system in equilibrium."

I fail to see, however, the advantage of assuming D'Alembert's principle as a fundamental law of mechanics, especially since he finds it necessary, in reality, to assume all of Newton's laws besides. Moreover the law itself

as he states it, and his applications of it, are rather confusing. It would be difficult indeed to put D'Alembert's principle in words so that a student at the beginning of his study of mechanics could grasp its significance. Any attempt would be apt to confuse rather than help the student.

Space will not permit me to go into further detail. To be brief, he seems inclined to introduce new difficulties, and to cover up the old ones. The book is not free from loose reasoning.

E. W. Rettger

Cornell University

Conservation of Water. By Walter McCulloh, C. E. Addresses delivered in the Chester S. Lyman lecture series, 1912, before the senior class of the Sheffield Scientific School, Yale University. New Haven, Yale University Press; London, Humphrey Milford, Oxford University Press. Cloth, $6\frac{1}{4} \times 9\frac{1}{4}$ in. Pp. x + 99; 39 illustrations. \$2. Postage, 15 cents.

At a time when the question of our water resources and a national policy regarding them is becoming a matter of increasing importance this book is very opportune. The lectures printed therein cover the following topics:

The first chapter considers the desirability of proper handling of our water supplies and the questions of legal jurisdiction over them. Then follows a chapter on the economic, hydrographic, topographic and geologic data necessary for an intelligent handling of the problem in any case. The third chapter gives some very interesting information in regard to the water power of the United States, both developed and undeveloped, with some statistics that are hard to collect otherwise. The value of storage reservoirs in connection with power developments is shown. The next chapter treats of water supplies for municipalities and the problems of sanitation and drainage. The last chapter describes in detail the water resources of New York state and the present important developments.

This is not a book for a specialist, already well informed in hydraulics, nor is it well adapted for use as a text-book for students. But for all readers who are interested in water resources and related problems it is a book that can be read with profit. It should be of especial value to the non-technical man who desires a broad understanding of the engineering principles involved.

R. L. Daugherty

Cornell University

Stuttering and Lisping. By E. W. Scripture. New York, The Macmillan Co. 1912. Pp. xiv + 251.

After many years of clinical work and private practise in the treatment of speech defects, Dr. Scripture has here written down many of his observations regarding the causes, symptoms and treatment of stuttering and chronic mispronunciation. As a cause of stuttering a "general anxiety neurosis" is emphasized but the author avoids much elaboration of this topic.

In the chapter on symptoms some etiology is necessarily considered and many interesting kymograph records of respiration, vocal and articulatory movements are reproduced. The method of taking these records is well illustrated by photographs, and their significance is discussed in the text. The treatment outlined is perhaps the most valuable contribution in the book and is systematically referred to the preceding diagnosis. The exercises in voice modulation—a method of treatment largely original with the author—are carefully described. Psychanalysis and suggestion are dealt with briefly.

The second part of the book treats of lisping, as it is of negligent, organic or neurotic origin. The mouth positions for articulating the different vowel and consonant sounds are indicated by diagrams, "palatograms" and photographs. Some valuable methods for inducing the patient to attain the proper positions are given. At the end of the book are fifty pages of exercises to be used in the treatment of both stuttering and lisping.

Stevenson Smith

University of Washington

SPECIAL ARTICLES

SOME PHYSIOLOGICAL OBSERVATIONS REGARDING PLUMAGE PATTERNS[1]

THIS study was undertaken with the object of carrying the analysis of the genetic factors for color pattern somewhat farther than has hitherto been done. In many forms of domestic poultry the plumage of particular parts of the body displays on each feather a definite and regular pattern. Experimental studies show that these patterns are inherited in a clean-cut Mendelian manner. In the case of the Barred Plymouth Rock color pattern, which has been more thoroughly studied in regard to its inheritance than any other single plumage pattern in birds, extensive investigations in this laboratory and elsewhere indicate that this barred pattern is represented in the gametes by a single Mendelian factor or gene. The manner in which this gene operates physiologically presents a problem of great interest, since it involves an element of morphogenetic localization.

With a view of getting further light on this matter a study has been made of the successive regeneration of feathers, in which special attention has been paid to the comparison of the pattern shown in the regenerates and in the original feather. It is the purpose here to make a preliminary statement regarding this work and some of the results obtained, to be followed later by a detailed account.

A word should be said in regard to one point of technique, since this made possible the carrying on of the investigation in a precise and critical manner. The point referred to is the method used for the identification of the individual feather follicle. If the feathers successively produced in the same follicle are to be compared, it is necessary that this particular follicle shall be capable of absolutely sure identification at any time, whether or not there is a feather present. This result was very satisfactorily attained by tattooing with india ink a circle around each follicle chosen for study. These tattoo marks are permanent throughout the life of the individual and make it possible to find at any time the follicle which one is studying.

A few of the more important results which have been obtained from this study, which has now been in progress about a year and a half, may be here set forth, as follows:

1. All feather follicles are not capable of continually producing successive feathers for an indefinite time. In the case of the general body plumage a feather is usually not regenerated more than about three times. The precise number of successive regenerations varies with different birds and different feathers. Wing primaries seem to possess the maximum regenerative capacity. After about the third removal in the case of body feathers the follicle usually remains in a perfectly quiescent condition, taking no steps whatever toward the regeneration of a new feather.

2. This failure to regenerate is, however, very definitely related to the natural moult of the bird, and in the following way. A follicle which has been absolutely inactive for a long period of time (*e. g.*, six months) preceding the natural autumn moult of the bird produces a new feather in connection with the moult, in the same manner as does any other follicle of the body. In other words the process of natural moulting reactivates the follicle which had been brought into a quiescent state by successive feather removal.

3. The precise pattern exhibited by a particular feather is, in the usual course of events, reproduced each time a feather is produced by that follicle with extreme fidelity of detail. If, however, the feather is removed from the follicle as soon as it is fully grown, thus forcing continued regenerative activity of the follicle, the pattern tends progressively to be broken up, and probably will ultimately be entirely lost as a definite pattern. The experiments have not yet gone far enough to enable us to speak positively on this latter point. A progressive breaking up of an originally definite pattern is, however, very clearly

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 60. This paper was read at the meeting of the American Society of Naturalists in Philadelphia, December 31, 1913.

shown in a number of cases.[2] The behavior of the color pattern in successively regenerated feathers suggests, as a working hypothesis, that the pattern factor or gene is possibly represented in each follicle by a strictly limited amount of material, and that when this is used up the pattern is lost.

4. The secondary sexual feathers of the male, such as the saddle hangers, only appear as adult plumage. The same follicles which bear these feathers produce, as juvenile plumage, undifferentiated body feathers. The formation of these secondary sexual feathers is not necessarily dependent upon any normal moult. If the juvenile feather is removed from the follicle the next feather produced by that follicle will be the secondary sexual feather, and not a feather of the juvenile type. After that all further regenerations are of the sexually differentiated feather.

These investigations are being continued. A complete report, with illustrations, covering the progress of the work to date will shortly be published elsewhere.

Raymond Pearl,
Alice M. Boring

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

The fifth annual meeting of the Pharmacological Society was held in Philadelphia on Monday and Tuesday, December 29 and 30, at Jefferson Medical College and the University of Pennsylvania. The scientific meetings were auspiciously inaugurated by a joint session of the three societies which form the Federation of American Societies for Experimental Biology, comprising the Physiological Society, the Society of Biological Chemists and the Pharmacological Society. The program of this joint meeting on Monday morning was opened by a short address of the president of the Physiological Society, Dr. S. J. Meltzer, as chairman of the federation. The title of his address was "Theories of Anesthesia."

The following papers were read and discussed:

"Phlorhizin Glycosuria before and after Thyroidectomy," by Graham Lusk.

"Studies in Diabetes: (1) The Effect of Different Compounds of Glycogenesis; (2) The Mechanism of Antiketogenesis," by A. J. Ringer and E. M. Frankel (by invitation).

"Some Problems of Growth: (a) The Capacity to Grow; (b) The Rôle of Amino Acids in Growth," by L. B. Mendel and T. B. Osborne.

"Further Studies in the Comparative Biochemistry of Purine Metabolism," by Andrew Hunter.

"Changes in Fats during Absorption," by W. R. Bloor.

"Immunization against the Anti-coagulating Effect of Leech Extract," by Leo Loeb. (Read by title.)

"Anaphylaxis in the Cat and Opossum," by C. W. Edmunds.

"Vividiffusion; Report on Preliminary Results," by J. J. Abel, L. S. Rowntree and B. B. Turner.

"A Method of Dialyzing Normal Circulating Blood and Some of Its Applications," by C. L. V. Hess (by invitation) and H. McGuigan.

"A Biological Test for Iodine in the Blood," by A. Woelfel and A. L. Tatum (by invitation).

"Further Studies of the Excretion of Acids," by L. G. Henderson and W. W. Palmer (by invitation).

The second scientific session was also held at Jefferson Medical College on Monday, December 29, from 2 to 5 P.M., and the following papers were read:

"Uranium Glycosuria," by G. B. Wallace and H. B. Meyers.

"A Comparative Study of the Vascular Response of the Kidneys in Animals Nephritic from Uranium Nitrate," by W. deB. MacNider.

"The Production of Glycosuria by Zinc Salts," by W. Salant and M. Kahn.

"Further Observations on Caffein Glycosuria," by W. Salant and M. Kahn.

"Studies upon the Long-continued Feeding of Saponin," by C. L. Alsberg and C. S. Smith.

"The Effect of the Inhalation of Ether upon the Irritability of the Voluntary Peripheral Motor Mechanism," by J. Auer and S. J. Meltzer.

"The Irritability of Muscle and Motor Nerve in Chloroform Anesthesia," by T. S. Githens and S. J. Meltzer.

"The Cessation of Respiration in Deep Ether Anesthesia and its Possible Relation to the Action of Ether upon the Peripheral Motor Mechanism," by T. S. Githens and S. J. Meltzer.

"The Anesthetic Tensions of Ether Vapor for Man," by W. M. Boothby (by invitation).

"Studies in the Absorption of Drugs," by R. A. Hatcher and Cary Eggleston.

[2] Some of which were shown in the charts used in connection with the reading of this paper.

"Fatal Action of Magnesium Sulphate by Absorption from the Intestines," by J. Auer and S. J. Meltzer.

"Liberation of Formaldehyde from Hexamethylenamine in Pathological Fluids," by P. Hanzlik.

The third scientific session was held on Tuesday, December 30, from 9 to 12 M., in the engineering building of the University of Pennsylvania, and the following papers were presented and discussed:

"On Certain Effects of Digitalis Administration on the Human Heart" (with lantern demonstration), by A. E. Cohn and F. R. Fraser (by invitation).

"Quantitative Studies of Vagus Stimulation and Atropin," by J. D. Pilcher.

"Experiments on the Cardiac Action of Camphor," by O. H. Plant.

"The Action of Sodium and Potassium Iodide on the Heart and Blood Vessels," by I. D. Macht (by invitation). (Read by title.)

"The Influence of Sodium Tartrate on the Circulation," by W. Salant and C. S. Smith.

"The Pharmacological Action of Tetra-methylammonium Chloride on the Circulation and Respiration," by A. S. Loevenhart.

"Two Types of Periodic Respiration Produced by Morphin," by H. G. Barbour.

"The Pharmacological Action of Certain Substances on the Lungs and Respiration," by D. E. Jackson.

"Some Further Observations on Trypan-red Iodine Compounds," by P. A. Lewis and R. B. Krauss.

"Clinical Studies with Caffein," by Lester Taylor (by invitation).

"Further Observations on the Action of Ergot," by W. Salant and S. Hecht.

"The Toxicity of Tin," by W. Salant and C. S. Smith.

On Tuesday afternoon, December 30, the three societies forming the federation held a joint meeting at the medical laboratories of the University of Pennsylvania. At this meeting only demonstrations were given and of these the demonstration of Drs. Abel, Rowntree and Turner was especially beautiful. The titles were as follows:

"The Influence of the Vagi on Renal Secretion," by R. G. Pearce.

"Stimulation of the Semi-circular Canals," by F. H. Pike.

"Demonstration of Vividiffusion," by J. J. Abel, L. G. Rowntree and B. B. Turner.

"The Determination of Blood Sugar," by P. A. Shaffer.

"Intestinal Peristalsis in Homarus," by F. R. Miller.

"Methods for Studying the Pharmacology of the Circulation," by C. Brooks.

"The Contour of the Intraventricular and the Pulmonary Arterial Pressure Curves by Two New Optically Recording Manometers," by C. J. Wiggers.

"Some Time-saving Laboratory Methods," by C. C. Guthrie.

"A Graphic Method for Recording the Coagulation of Blood," by W. B. Cannon and W. K. Mendenhall (by invitation).

"Some Mutual Relations of Oxalates, Salts of Magnesium and Calcium; Their Concurrent and Antagonistic Actions," by F. L. Gates and S. J. Meltzer.

"A Method for Obtaining Successive Contrast of the Sensations of Hunger and Appetite," by A. J. Carlson.

"Further Observations of the Pyramidal Tracts of the Raccoon and Porcupine," by S. Simpson.

"A New Apparatus for Demonstration of the Dioptrics of the Eye and the Principles of Ophthalmoscopy and Retinoscopy," by A. Woelfel.

"Simple Experiments on Respiration for the Use of Students," by Y. Henderson.

"Convenient Modification for Venous Pressure Determinations in Man," by R. D. Hooker.

"Device for Interrupting a Continuous Blast of Air, Designed Especially for Artificial Respiration," by R. A. Gesell and J. Erlanger.

"A Simple Liver Plethysmograph," by C. W. Edmunds.

"An Artificial Circulation Apparatus for Students," by W. P. Lombard.

"A Simplified and Inexpensive Oxidase Apparatus," by H. H. Bunzel.

"An Improved Form of Apparatus for Perfusion of the Excised Mammalian Heart," by M. Dressbach.

Business Meetings

Executive sessions were held by the Pharmacological Society on Monday, December 29, at 5 P.M. and on Tuesday, December 31, at 12:30 P.M. The following officers were elected for the year 1914:

President—Dr. Torald Sollmann.

Secretary—Dr. John Auer.

Treasurer—Dr. William deB. MacNider.

Additional members of the council—Dr. John J. Abel, Dr. A. L. Loevenhart.

Membership committee—Dr. Reid Hunt (term expires 1916).

Election of New Members.—The names of the following candidates were sent to the council by the membership committee, recommended for election by the council and elected by the society: Dr. A. E. Cohn, Rockefeller Institute, New York City; Dr. H. F. Helmholtz, Sprague Memorial Institute, Chicago, Ill.; Dr. W. A. Jacobs, Rockefeller Institute, New York City; Dr. Hugh MacGuigan, Northwestern Medical School, Chicago, Ill.

Federation News.—A detailed statement of the developmental effect which this first meeting of the three societies has exerted upon the federation formed at present by these societies, will be given by the general secretary of the federation for the year 1913, Dr. A. J. Carlson. Only one action, that of the Pharmacological Society, need be reported here. It will be remembered that delegates from the Physiological, Biochemical and Pharmacological societies met in Cleveland last year (1912) to establish a federation of the American societies for experimental biology. Among the motions passed unanimously was one which provided for the shifting of papers, with the author's consent, from the program of one society to that of another, if it were considered advisable by the secretaries. In order to prevent a possible conflict with the spirit of Section 2, Article III, of the constitution of the Pharmacological Society, which states that no one shall be admitted to membership who is in the permanent employ of any drug firm, a motion was put and carried unanimously by the Pharmacological Society in its executive session, recommending that no paper should be transferred to the program of the Pharmacological Society without the explicit consent of its secretary. This was done in order to prevent as far as possible the appearance of any paper of a commercial nature on the programs of the Pharmacological Society, for the other two members of the federation do not have this clause which excludes from membership those in the employ of business concerns. It may be stated that the Pharmacological Society did not take this action because of any specific occurrence, but because the society deemed it proper at this time to again emphasize its individual position in the matter.

Dinners and Smokers.—Excellent subscription dinners of very moderate cost formed an enjoyable feature of the Philadelphia meetings and were attended not only by the members of the federation, but also by the Naturalists, Zoologists and Pathologists. They were held on the evenings of December 29 and 30 at the Walton Hotel and Kugler's restaurant, respectively. There were only a few speeches; at the first dinner Drs. W. W. Keen and S. J. Meltzer spoke; at the second dinner the Naturalists presided and Dr. Raymond Pearl delivered a short address.

At the last executive session of the society a motion was passed unanimously to thank the local committee representing the University of Pennsylvania and Jefferson Medical College for the comprehensive and efficient way with which all arrangements for the meetings and the visitors' comfort were made. No names are mentioned in this expression of appreciation because the secretary is informed that practically every Philadelphia member of the three constituent societies labored on the local committee to make the first meeting of the federation as enjoyable as possible. It will be the opinion of every one present that their efforts were entirely successful, that the visitors attended with pleasure and left with regret.

John Auer,
Secretary

The Rockefeller Institute

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At a special meeting of the Society held on November 4, at the National Museum, Dr. John R. Swanton read a paper entitled, "The Indian Village." He stated that while it is a common notion that country life preceded urban life, this view is not absolutely correct, urban life in its germs going back almost as far as man himself. He then took up the various factors tending to produce the village, determine its character, and subsequently knit it together. These he found to be of three orders, material, social and religious. Among the first he enumerated material available for the construction of houses, position with reference to the food supply and fresh water, and occasionally also position with reference to the sun. Among social factors he treated trade, desire for exchange of ideas, need of mutual protection and relationship, especially in the peculiar form it assumed under totemism. Finally the growth of a village or town cult was traced from the practical independence of shamanism pure and simple to the complete town ritual, sometimes directly, sometimes through the fusion of clan ceremonies

and sometimes through the rituals of religious or other societies. These factors were illustrated by reference to the tribes of the North Pacific Coast and the Gulf area. A possible evolution was suggested in three stages, first, the haphazard collection of hunters, fishers, or perhaps agriculturalists, in a certain spot; second, the development of social relations among them, particularly through intermarriage, and thirdly, a religious seal or stamp of unity, though it was not the writer's intention to set this up as a hard and fast process of evolution. It was noted that totemic clans among some tribes might have been evolved in a similar manner. In conclusion, a short comparison was made between the Indian village and the modern city, attention being called to the fact that in the latter the most important determining factor is trade, while in the former relationship, religious observances, and to some extent motives of protection, were much more prominent.

The subject was discussed at some length by Mr. J. N. B. Hewitt, who confined his remarks to the village in the social organization of the Iroquois. The basis of the social organization was actual or fictitious blood kinship traced through the mother. The cohesiveness of the several units was obtained through the ties of duty and privilege subsisting between clans united by the marriage of their sons and daughters. The clans were organized into two phratries or sisterhoods of clans, one of which represented the masculine and the other the feminine, in nature. This division was maintained in all public meetings. The one side was, therefore, called the "father side," and the other, the "child side," which of course was the "mother side." Strong lines of actual or artificial kinship and cleavage existed between these two groups.

The clans' totems have no especial religious significance at present, that is, there are no ceremonies in honor of them. That there were such in early times is quite possible. The decadence of the worship of the clan totem was probably due to the unification of the clan government into that of the tribe, and later, of the tribe into that of the confederation. The great influence of the council of women, composed of mothers only, in the affairs of the village and tribe and confederation was emphasized, and illustrated by the effectiveness with which they could stop or prevent a war. They needed only to forbid their sons to engage in warlike activity under penalty of becoming outlaws to the tribe and confederation. The gradual adoption of the Tuscarora tribe of North Carolina by the Iroquois League on motion of the Oneidas as their sponsors, was described, the Tuscaroras being first regarded as infants, then as boys who were not allowed to take part in the wars and councils of the League, and then, finally, as warriors having their own federal chiefs to represent them in the Federal Council of the League.

The 469th regular meeting of the society was held November 25, 1913, the president, Mr. Stetson, in the chair.

Dr. Daniel Folkmar, who has charge of the report on "Mother Tongue" in the Bureau of the Census, addressed the Society on "Some Results of the First Census of European Races in the United States." Statistics of the mother tongue, or native language, of the "foreign white stock" of the United States are presented in the report soon to be issued by the Bureau of the Census. It was prepared under the supervision of the chief statistician for population, assisted by the speaker as expert special agent. There are presented, for the first time in the census, figures directly relating to the ethnic composition of the white population of the United States, in so far as that is indicated by the native language. This term is taken to mean the language of customary speech in the homes of the immigrants before immigration.

One of the most interesting facts disclosed in this report is the great numerical preponderance which is still held by the mother tongues of northwestern Europe, as a whole, notwithstanding the high rank numerically which has been gained by a few individual mother tongues from eastern and southern Europe—especially the Italian, Polish and Yiddish. These three now stand third, fourth and fifth in rank. The English and Celtic mother tongues are by all odds the ones most largely represented in the foreign white stock of the United States. The number, 10,037,420, is considerably greater than that of the German mother tongue, which latter contributes more than one fourth (27.3 per cent.) of the total foreign white stock of the United States, as reported in 1910. Italian, Polish and Yiddish come next in rank, but none of them number as much as one fourth of the German. To these three mother tongues, intermediate in rank but considerable in numbers, may be added the Swedish, French and Norwegian, all belonging to northwestern Europe, except a por-

tion of the French. No other mother tongue than the eight thus far enumerated furnishes as much as 2 per cent. of the total of the foreign white stock of the United States, or numbers as much as 1,000,000. The eight major mother-tongue stocks already named account for 87.5 per cent. of the total foreign white stock.

How small a factor the "new" immigration from southern and eastern Europe really is up to the present time, may be better shown by comparing it with the total white population of the United States. Taking as 100 per cent. the total white population of the United States in 1910, numbering 81,731,957, the so-called "native stock" constitutes 60.5 per cent. and the three great linguistic families of foreign stock from northwestern Europe constitute 27.1 per cent., making a total of 87.6 per cent. The elements from southern and eastern Europe constitute, therefore, less than 13 per cent. of the total. Of this the two principal Latin mother tongues—the French and the Italian—contribute less than 5 per cent., and the two principal Slavic mother tongues—the Polish and the Bohemian—and the Hebrew, taken together, contribute also less than 5 per cent., leaving to all the remaining mother tongues another 5 per cent. or less of the total. Of the total foreign white stock of the United States, 32,243,382, there are 8,817,271 persons who are of German stock when counted according to mother tongue, but a trifle under 8,500,000 (8,495,142) of German stock when counted by their country of origin, Germany.

Immigrants from Austria are far more Slavic than Germanic. Russian immigration is shown to be far more Hebrew (52.3 per cent.) than Russian (2.5 per cent.) or even Slavic. Immigration from Turkey in Europe is not so much Turkish as Greek and Bulgarian. Both the first and the second generations of immigration from Russia show that over 50 per cent. report Yiddish and Hebrew as their mother tongue. The returns for "Yiddish and Hebrew" reflect ethnic composition less satisfactorily than the returns for other mother tongues. A part—how large a part there is no means of judging—of those whose ancestral language is Hebrew doubtless have reported German, English, Polish or other mother tongues. Of the total number of Yiddish-speaking people 838,193 came from Russia, 144,484 from Austria-Hungary, 41,342 from Roumania, 14,409 from the United Kingdom, and 7,910 from Germany.

The full list of mother tongues as reported at the Thirteenth Census is given for the total foreign white stock (which includes the foreign born and the natives of foreign or mixed parentage) and for the foreign-born whites separately, as follows:

Mother Tongue	Total Foreign White Stock, 1910	Foreign born White
All mother tongues	32,243,382	13,345,545
English and Celtic[1]	10,037,420	3,363,792
Germanic:		
German	8,817,271	2,759,032
Dutch and Frisian	324,930	126,045
Flemish	44,806	25,780
Scandinavian:		
Swedish	1,445,869	683,218
Norwegian	1,009,854	402,587
Danish	446,473	186,345
Latin and Greek:		
Italian	2,151,422	1,365,110
French	1,357,169	528,842
Spanish	448,198	258,131
Portuguese	141,268	72,649
Roumanian	51,124	42,277
Greek	130,379	118,379
Slavic and Lettic:		
Polish	1,707,640	943,781
Bohemian and Moravian	539,392	228,738
Slovak	284,444	166,474
Russian	95,137	57,926
Ruthenian	35,359	25,131
Slovenian	183,431	123,631
Serbo-Croatian:		
Croatian	93,036	74,036
Dalmatian	5,505	4,344
Servian	26,752	23,403
Montenegrin	3,961	3,886
Bulgarian	19,380	18,341
Slavic, n. s.	35,195	21,012
Lithuanian and Lettish	211,235	140,963
Miscellaneous:		
Yiddish and Hebrew	1,676,762	1,051,767
Magyar	320,893	229,094
Finnish	200,688	120,086
Armenian	30,021	23,938
Syrian and Arabic	46,727	32,868
Turkish	5,441	4,709
Albanian	2,366	2,312
All other	790	646
Unknown	319,044	116,272

Daniel Folkmar,
Secretary

[1] Includes persons reporting Irish, Scotch or Welsh.

SCIENCE

FRIDAY, JANUARY 30, 1914.

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DOCTOR'S DREAM[1]

DR. SMITH is a practitioner in one of the large cities of the middle West. He is a man of good training, a classical graduate, took his professional course in one of our best schools, and did hospital service both at home and abroad. He is a general practitioner and keeps well posted in all that he does. He makes no claim to universal knowledge or skill, but is conscientious in all his work, and when he meets with a case needing the service of a specialist he does not hesitate to call in the best help. He has made a good living, demands fair fees from those who are able to pay, and gives much gratuitous service to the poor. He is beloved by his patients, held in high esteem by his confreres, and respected by all who know him. He is a keen observer, reads character for the most part correctly, and is not easily imposed upon. While he recognizes the value of his services, he is not in the practise of medicine with the expectation of getting rich, and his interests are largely humane and scientific. He has deep sympathy for those whose ignorance leads them to sin against their own bodies, but he is devoid of weak sentimentality and does not hesitate to admonish and even denounce the misdeeds of his patients whatever their social position. During twenty years of practise in the same locality he has become acquainted with the vices and virtues of many families. He is not looking for the coming of the millenium, but he is often impatient of the slow pace with which the race moves

[1] Read at the seventh annual meeting of the Association of Presidents of Life Insurance Companies, December 11, 1913.

towards physical, mental and moral betterment. One of his patients is a large manufacturer employing many unskilled laborers. Dr. Smith has often pointed out to this man that the efficiency of his working force would be multiplied many times were the men paid better wages, the work done in rooms better lighted and ventilated, and in general with a little more humaneness shown them. Another is at the head of a large mercantile house which employs clerks at the lowest possible wages and makes the conditions of life well nigh unendurable. A wealthy woman gives largely to church and charity from her revenues which come from the rental of houses in the red light district. Another of the doctor's patrons is a grocer who sells "egg substitutes" and similar products "all guaranteed under the pure food law." We will not continue the list of the doctor's patrons and it must not be inferred that all are bad, for this is not true. The majority are honest, conscientious people, as is the case in all communities. Our country has a population of nearly one hundred millions. Millions of these are decent, respectable citizens, not altogether wise, but for the most part well intentioned. Thousands are brutal in their instincts, criminal in their pursuits, and breeders of their kind. We claim to be civilized, but there are those among us who would be stoned to death were they to attempt to live in a tribe of savages. But I must stop these parenthetical excursions and get back to Dr. Smith and his dream. On a certain day in November of the present year he had been unusually busy, even for one whose working hours frequently double the legal limit. During his office hours he had seen several cases which gave him grave concern. There was William Thompson, the son of his old classmate and college chum, now Judge Thompson. William finished at the old university and is now an embryo lawyer promising to follow in the footsteps of his honored and honorable father, but William belonged to a fast fraternity at college and came to Dr. Smith this morning with copper-colored spots over his body and a local sore. The doctor easily diagnosed the case and pointed out to William that he was a walking culture flask of spirochetes, a constant source of danger to all who should come in contact with him, and that years of treatment would be necessary to render him sound again. On the lip of a girl, the daughter of another old friend, the doctor had found a chancre caused by a kiss from her fiancé, a supposedly upright man prominent in church and social circles. He had seen a case of gonorrhea in a girl baby contracted from her mother, the wife of a laboring man. A case of gonorrheal ophthalmia in a young man whose only sin was that he had used the same towel used by an older brother next demanded his attention. Several cases of advanced tuberculosis among those who had been told by less conscientious physicians that the cough was only a bronchial trouble made Dr. Smith lament the standard of skill and honor among some of his professional brethren. Rapid loss in weight in an old friend who had been too busy to consult him earlier was diagnosed as neglected diabetes. In another instance dimness of vision and frequent headaches persisting for months had not sufficed to send an active business man to the physician. This proved to be an advanced case of Bright's disease, which should have been recognized two years earlier. Urinary, ophthalmoscopic and blood pressure tests demonstrated the seriousness of the present condition. A breast tumor on the wife of an old and respected friend showed extensive involvement of the axillary glands and the operation demanded promised only temporary relief, while

had it been done months before, complete removal of the diseased tissue would have resulted. In making his calls for the day Dr. Smith had experienced both among the well-to-do and the poor many things which had brought within the range of his vision more and darker clouds than those which floated in the dull November sky. More than a year before he had become estranged from the family of one of his oldest and best friends. The breaking of this relationship which had continued from his earliest professional service and had been filled with the common joys and sorrows shared only by the family physician and those under his charge, had cast a deep shadow over the doctor's life. He had officiated at the birth of each of his friend's five children, and he felt a parental love and pride in them as he saw them grow into healthy womanhood and manhood. A little more than a year ago, he learned that the eldest of these children, a beautiful and healthy girl of eighteen, was engaged to a young man whom he knew to be a rake. In a spirit of altruism he had gone to the father and mother and protested against the sacrifice of the daughter. This kindly intended intervention was met with a stormy rebuff, and the doctor was rudely dismissed from his friend's house. But when the young woman whose life with her unfaithful husband had made her deeply regret her fatal infatuation, felt the first pains of childbirth she begged of her parents that her old friend might be sent for, and that morning he had delivered her of a syphilitic child. How unlike the previous births at which he had officiated in this friend's house! It had been the custom to have the doctor at every birthday dinner given the five children, and one of the boys bore his name. There would be no birthdays for this, the first grandchild, and what could the future promise the young mother? Surely, the November day was overcast with clouds for Dr. Smith before its gray light awoke the slumbering city. As he walked the few short blocks from his friend's to his own home, he cried in deepest sorrow how many thousands of daughters must be sacrificed before their parents will permit them to walk in the light of knowledge and not in the shadow of ignorance. After a breakfast, which was scarcely tasted, he read in the morning paper that the announcement that "Damaged Goods" was to be given in his University town had met with such a storm of protest from the learned members of the faculty that the engagement had been cancelled. "Surely," he said, "the fetters of prudery and custom bind both the learned and the unlearned."

After his morning office hours Dr. Smith visited his patients at the city hospital. Here is a wreck from cocaine intoxication, the poison having been purchased from a drug-store owned by a prominent local politician. In a padded cell is a man with delirium tremens, a patron of a gilded saloon run by another political boss. In the lying-in ward are a dozen girls seduced in as many dance halls with drinking alcoves. Time will relieve these girls of the products of conception, a longer time will be required to free them from the diseases which they have contracted, but all time will not wash away the stains on their lives, and what of the fatherless children to be born? Thirty beds are filled with typhoids, who under the best conditions must spend long weeks in the bondage of a fever, which day by day gradually but inexorably tightens its grasp. The furred tongues, glazed eyes, flushed cheeks, bounding pulses, emaciated frames, delirious brains were all due to the fact that a large manufacturer had run a private sewer into the river above the water works. The greed and ignorance of one business firm had

been permitted to endanger the lives of half a million of people. In his family calls the doctor met with conditions equally lamentable. A fond mother in her ignorance had nursed a sore throat in one of her children with domestic remedies. The membranous patches on the tonsils, extending upward into the nasal passages and downward into the larynx, and the cyanotic face with labored breathing showed that even the magical curative action of diphtheria antitoxin, that wonderful discovery of modern medicine, would be of little avail in this individual case. The other children were treated with immunizing doses and the doctor had the consolation of knowing that death's harvest in that household would be limited to the one whom the mother's ignorance had doomed.

The next call brought Dr. Smith to a home in which the conditions were equally deplorable and still more inexcusable. One of the children some months before had been bitten by a strange cur which soon disappeared in the alley. The wound was only a scratch and was soon forgotten. Now, the child was showing the first symptoms of that horrible disease hydrophobia. But dogs must not be muzzled. Women with plumes, torn from living birds, in their hats, formed a society for the prevention of cruelty to animals, and so declared.

It must not be inferred that all of Dr. Smith's experiences on that November day were sad. Men are mortal; all sickness is not preventable, accidents will happen and distressing injuries result. This world is not an Eden and no one expects that all sorrow will be banished from it. Decay and death approach with advancing years. Strength and weakness are relative terms and those possessed of the former must help bear the burdens of those afflicted with the latter. Dr. Smith being a hard-headed, reasonable, scientific man, is no Utopian, and he frequently meets in sick rooms experiences which greatly increase both his interest and his confidence in man. He finds the young and vigorous denying themselves many pleasures in order to brighten the pathways of the old and infirm, the fortunate lending a helping hand to the unfortunate, and the wise leading the unwise. No one, more than the family physician, can measure and appreciate the innate goodness that springs without an effort from the heart of humanity. It is difficult for the physician of large experience to unreservedly condemn any one, and he is inclined to regard all sins as due to either heredity or environment. However, it must be admitted that on this day Dr. Smith had seen but little sunshine and the clouds that had gathered about him had hidden the virtues and magnified the vices of his community, and especially was this true of the vice of ignorance, for ignorance which results in injury to one's fellows is not only a vice but a crime, a moral, if not a statutory one.

Late that night as the doctor sat before his grate he fell asleep, and now he is busy among his patients in a way hitherto quite unknown to him. His waiting-room is filled with people, old and young, of both sexes, who have come to be examined in order to ascertain the exact condition of their health. A young man before proposing marriage to the woman of his choice wishes a thorough examination. He wishes to know that in offering himself he is not bringing to the woman any harm. He desires to become the father of healthy children and he is not willing to transmit any serious defect to them. He tells the doctor to examine him as carefully as he would were he applying for a large life insurance. The doctor goes through the most thorough physical examination and tests the secretions and blood with the utmost care. He

understands his own responsibility in the matter and appreciates the high sense of honor displayed by his patient. A young woman for like reasons has delayed her final answer to the man who has asked her hand in order that the doctor might pass upon her case. Here is the doctor's old friend, William Stone. Mr. Stone is in the early fifties. He has been a highly successful, honorable business man, has accumulated a sufficiency and enjoys the good things which his wife prepares for the table. A careful examination of the urine leads the doctor to caution Mr. Stone to reduce the carbohydrates in his food. Mr. Perkins, a lawyer who throws his whole strength in every case he tries, and of late has found himself easily irritated, shows increased urinary secretion and a blood pressure rather high. A vacation with light exercise and more rest is the preventive prescription which he receives. Mrs. Williams, after being examined by Dr. Smith, undergoes a slight operation under local anesthesia, and is relieved of the first and only malignant cells found in her breast. Richard Roe, who is preparing for a long journey, is vaccinated against typhoid fever, a disease no longer existent in Dr. Smith's city since pollution of the water has been discontinued. John Doe, who is a mineralogical expert and wishes to do some prospecting in high altitudes, has his heart examined. There are numerous applicants for pulmonary examination. This is done by Dr. Smith and his assistants in a most thorough and up-to-date manner, and advice is given each according to the findings. It has been many years since Dr. Smith has seen an advanced case of pulmonary tuberculosis and the great white plague will soon be a thing of the past. Every body goes to a physician twice a year and undergoes a thorough examination. The result of this examination is stated in a permanent record and no two consecutive examinations are made by the same physician, in order that a condition overlooked by one may be detected by another. Cases of doubt or in which there is difference of opinion are referred to special boards. The average of human life has been greatly increased and the sum of human suffering has been greatly decreased. Preventive has largely replaced curative medicine. Tenements are no longer known; prostitution and, with it, the venereal diseases have disappeared; institutions for the feeble-minded are no longer needed, because the breed has died out; insanity is rapidly decreasing because its chief progenitors, alcoholism and syphilis, have been suppressed. These and many other pleasing visions come to Dr. Smith in his dream, from which he is startled by the ring of the telephone at his elbow. The call says: "Come quickly to Pat Ryan's saloon at the corner of Myrtle and Second. There has been a drunken row. Bring your surgical instruments." Then the smiles which had played over the face of the doctor in his dream were displaced by lines of care and he went forth into the darkness of ignorance and crime.

There are many Dr. Smiths and they have been seeing pleasing visions in their dreams and meeting with stern realities in their waking hours. Nearly fifty thousand Dr. Smiths constitute the American Medical Association which is expending thousands of dollars annually in trying to so educate the people that unnecessary disease will be prevented. The doctors are asking that the work of the national, state, municipal and rural health organizations may be made more effective, that the knowledge gained in the study of the causation of disease may be utilized. The world has seen what has been done in Havana and on the Canal Zone, how yellow fever and malaria

have been suppressed, and how the most pestilential spots on earth may be converted into healthful habitations for man. Scientific medicine has made these demonstrations and the world applauds, but seems slow to make general application of the rules of hygiene.

Dr. Foster had experienced the doctor's dream when he said to you in 1909:

I look forward with confidence to the time when preventable diseases will be prevented, and when curable diseases will be recognized in the curable stage and will be cured, and I believe the grandest triumphs of civilization will be the achievements which will result from a realization of the possibilities of preventive medicine.

Professor Fischer, a most earnest and intelligent student of the prevention of sickness and the deferring of death has stated that "by the intelligent application of our present knowledge, the average span of human life may be increased full fifteen years."

It has been proposed that the life insurance companies represented here seek to prolong the lives of their policyholders by offering them free medical reexamination at stated intervals. It has been shown that in all probability this would financially benefit the companies in the increased longevity of their policyholders and the increased number of premiums they would pay. This is a business proposition, and I hope that the companies will inaugurate it and thus demonstrate that the lessening of sickness and the deferring of death will pay. Let the insurance men join the doctors and help in the great work for the uplift of the race through the eradication of unnecessary disease and premature death. In this way we can hasten the coming of the better man by making the doctor's dream a reality. I am confident that you will do this, not because it will pay, but because it is the highest service you can render humanity.

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UNIVERSITY OF MICHIGAN

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SCIENCE, EDUCATION AND DEMOCRACY[1]

SCIENCE, education and democracy—the three great enterprises of the modern world—are in no institution more completely represented than in this American Association for the Advancement of Science and in its section of education. We are organized to advance science in all its range from the most esoteric deduction of the mathematician to the most homely contrivance of the inventor, and at the same time to diffuse scientific knowledge and scientific method among all who are willing to listen. Our membership includes the ablest scientific leaders and equally those who in Bishop Berkeley's phrase are "undebauched by learning." We migrate from place to place for our meetings in order that we may teach and learn in all parts of the country. We form more nearly a democracy of science than any other organization. Education is amalgamated with every section of our association, which is as completely an educational institution as is a university. And as the university, devoted throughout to education, yet may include a department or school of education, so we have conducted in recent years a section of education. This section is concerned with the place of the sciences in our educational system and with improving the methods of teaching them. It has also as its object, perhaps its principal object, the development of a science of education; for there is no other applied science—not agri-

[1] Address of the vice-president and chairman of the Section of Education of the American Association for the Advancement of Science, read at Atlanta, Ga., on December 31, 1913.

culture, nor engineering, nor medicine—of equal importance. It is also true that none is more backward and empiric, none in greater need of scientific principles and scientific methods.

The adequacy of much of our mathematical teaching is illustrated by the high-school boy's answer to the question "What follows when the three sides of a triangle are equal?", this being "The other side will be equal too." However that may be, science, education and democracy are the essential sides of the triangular base on which rests the pyramid of the civilization that we have, on which will stand even more solidly the better civilization that is to be. The foundations we can follow downward as far as we may fancy—to prehistoric and prehuman times, to metazoa and protozoa which learn by experience and have a certain equality of opportunity. In the long course of evolution, science and education always have been interrelated. Accumulated and transmitted knowledge has been the basis of education, and in turn education has made possible the accumulation and transmission of knowledge. Thus have come language and writing, the alphabet and printing, tools and machines, fire and shelter and clothing, the cultivation of plants and animals, fine arts and religions, sciences and their applications, codes of conduct and methods to enforce them.

During the historic period there has been a conflict between science and education, on the one side, and democracy, on the other. Among the lower animals and to a certain extent in savage tribes, there exists a kind of democracy and equality of opportunity. Each individual faces the world with the endowment received at birth, not greatly helped by the position of his family or his group. But when knowledge and education became so complicated that they could not be shared equally by all, when wants increased to the extent that some had to be deprived in order that others might be gratified, when there was competition for property and wealth, then society was thrown into a patriarchal or feudal or despotic or oligarchic system. The material resources did not suffice to provide adequately for all; the stronger seized on them, and the many were compelled to toil in ignorance and poverty in order that the few might enjoy knowledge, leisure and luxury. Unto those who had was given and from those who had not was taken even that which they had. The system of individual, family, class, race and sex privilege gained the saddle and still rides us all.

The dominance of privilege was perhaps a necessary stage in social development. It may be that power and wealth concentrated in individuals, citizens and slaves, an aristocracy exploiting serfs, dependent women, subject races, were required to save the primitive state from submergence under savagery and barbarism, to develop its institutions, to promote science and the arts, to set standards of conduct. Plato provided slaves for his republic; the New Testament accepted Cæsar, slavery and the subjugation of women. When the resources of society were sufficient to provide adequately for only a part of its members, universal education and equality of opportunity could not exist. The masses were compelled to work incessantly for the bare necessities of life, in order that there might be classes in a position to advance science and the arts. When the average age at death was twenty years, the race could only be continued if women spent their lives in bearing, rearing and burying their children.

But science with its applications has recreated the world. Within a century, or at most two centuries, it has quadrupled the efficiency of labor and doubled the length of life. Steam and electricity enable one

man to do what formerly required a hundred. A needle or a lucifer match is worth a thousand times what it costs. The mail which I send and receive daily at an expense of two or three dollars would cost hundreds of thousands of dollars if each piece were delivered separately without modern methods of transportation. It would take all the time of all the people in the United States to write part of what they now print. In the western world famine is no longer a factor. Cholera, smallpox and the plague have decreased their toll to less than one per cent. of what they once claimed. Infant mortality has been reduced from forty to ten in a hundred. The average life of a woman after the birth of her last child is perhaps three times what it was.

The economy of labor and of life which the applications of science have wrought has abolished the need of productive toil by children and has made possible their universal education. The wealth of society is now sufficient to support adequately every child, to give it the education that opens the gateway to the career for which it is fit, to provide equality of opportunity and a true social democracy. At the same time this education, which can be continued through life, for not more than four hours a day of routine labor by each adult would suffice to provide its necessities, gives the basis for a stable and complete political democracy. The exploitation of children, sex slavery, industrial servitude, kleptocratic classes, have become wanton and intolerable. It is also true that in addition to its economic control, science has been a dominant factor in education and in life. It not only makes the education of all possible, but its subject matter and especially its methods supply the best material for education. It gives us leisure and at the same time means to use leisure worthily. It has lessened ignorance, superstition and unreason; it has taught us to tell the truth as we see it, and in increasing measure to see the truth as it is.

Material science has provided the economic foundations of democracy. I believe that the science of conduct justifies democracy and will guide its laws and institutions. But this, it must be acknowledged, is only a matter of opinion. One of my college friends has become perhaps the most distinguished mathematical physicist of the world. Standing for parliament recently, the four principal theses of his electoral address were: Maintenance of a hereditary house of lords, introduction of a protective tariff, the denial of home rule to Ireland, state schools under the church. These reactionary policies were endorsed by his election to represent one of the great English universities. So little do intelligence, character and scientific attainment lead to agreement in regard to social and political theories. Each of us is enmeshed in the net of his class, and has but little freedom of movement. The individual does not as a rule act in the light of reason, but by instinct and impulse, and it is well that he does, for they are the safer guides. But while individual conduct is in the main automatic response to chance circumstance, it is possible by forethought to select individuals and to arrange circumstances. Education and scientific research are subject to social control and should be the chief concern of a democratic society.

American democracy has been on the whole favorable to common-school education. It is admitted that our masters must be taught, and in practise this country has led in public elementary education and now leads in the provision of high-school and college education. More than 96 per cent. of all children from ten to fourteen years of age are enrolled in school. There are

one million two hundred thousand students in high schools; a third of a million in higher institutions. Reading and writing have become, like air and water, the common heritage of all. This is the great achievement of democracy in the modern world. Thereby it has assured its own permanence and has opened up the way along which it will advance.

Reading and writing are indeed only pass-keys which unlock various gates. Further progress by way of the newspaper and the moving-picture show is halting. We have inherited the educational ideals of the idling classes and their dependent priests and clerks. The common school prepares for the high school, the high school for the college, the college for "Who's Who." Our scholastic methods, invaluable for intercommunication at a distance in space and time, may inhibit thought and action, even the finer forms of speech and the more direct expression of the emotions. A few days since a neighbor in the country, now over eighty years old, who suffered or enjoyed such educational limitations that she can barely read, wrote to me "I am still alive but i don't know what for." At school she would have been taught to use modestly a capital "I" for the first personal pronoun and not to end a sentence with a preposition. I have learned these things and to use words such as "direct" and "effective," but I do not use words so directly and effectively as my neighbor. One of my children at the age of ten, never having been in school, wrote verses such as:

> An army marching through the fields
> They had on their shields
> They were ready to fight until night
> But there was no army to fight

and

> The breeze that blows is the salt sea breeze

After instruction in English she relapsed into the conventional and the commonplace.

Who now can write a sentence such as "In the beginning God created the heaven and the earth," or sentences such as are found on every page of Homer and Dante? In the words of Arnold:

> What girl
> Now reads in her bosom as clear
> As Rebekah read, when she sate
> At eve by the palm-shaded well?
> Who guards in her breast
> As deep, as pellucid a spring
> Of feeling, as tranquil, as sure?
>
> What bard,
> At the height of his vision, can deem
> Of God, of the world, of the soul,
> With a plainness as near,
> As flashing as Moses felt
> When he lay in the night by his flock
> On the starlit Arabian waste?
> Can rise and obey
> The beck of the Spirit like him?

We do not know what well-educated men and women who could not read would be like. If the authors of the Homeric poems could read and write they did not spend much time in such occupations. Certainly they did not learn to use their own language by the study of Latin. A friend asked a porter in a Swiss hotel, who used many languages with equal facility and incorrectness, which was his native tongue. He replied that he did not know, he spoke all languages; then, in answer to the question as to the language in which he thought, "I neva tink."

Children must learn to read, write and calculate, but under proper conditions of family and society schools to teach these tricks would be nearly as superfluous as schools to teach infants to walk and talk. Those familiar with the literature of pedagogic edification will be weary of the iteration that the word "educate" means to lead out, which, not cramming full, should

be the object of our schools. This is not only trite, but also true. Every psychologist knows that perceptions are not there to be perceived, but as a condition of reactions; that we learn by doing; that conduct is the only thing that counts. But it is also true that by its etymology the word "educate" might mean to lead out the individual for the work for which he is fit, to select the "dukes," the leaders, for a democracy. This is the greatest service of education. We learn to do things not by preparing to do them, but by doing them; we get a wider outlook not by so-called cultural studies, but by association with those who have broad and unselfish interests; we must learn what others know, but it is more important to do what we have not been taught and what others have not done. The chief object of the school is to open for each child the gateway to the career for which he is fit. Democracy does not mean equal mediocrity of all, but performance by each in accordance with his ability.

What a man can do is prescribed at birth; what he does depends on opportunity. The famous clause "all men are created equal" was probably intended by Jefferson to mean equal in respect to life, liberty and the pursuit of happiness. However that may be, the doctrine of evolution by natural selection has taught every one that the individuals of a species are unlike at birth. The amount of congenital unlikeness in men and the extent to which it is inherited in successive generations, on the one hand, and the degree to which men can be fitted by education and experience for different performances, on the other hand, are scientific problems on the solution of which depends the future of social and political institutions. If superior ability occurs only or chiefly in certain family lines, if classes, races and the sexes are not only different but subordinated one to the other by the barriers of an impassable heredity, then an aristocratic society and an oligarchic government are imposed by nature. If each finds of necessity his level and his place by native endowment, then universal education and equality of opportunity are of small significance. If, on the contrary, among five children taken at random from the public schools, one is likely to surpass in ability and character the privileged boy at Groton or St. Paul's; if nine boys out of ten and ten girls out of ten have no chance to show what they are fit to do, then our need is more democracy and better opportunity for the fit.

I have found that of our thousand leading men of science, 134 were born in Massachusetts, 3 in Georgia. For each million of their population, Massachusetts and Connecticut have produced a hundred scientific men of high standing; the states of the southern seaboard but two. Does this disparity measure difference of natural ability or difference of opportunity? The frailties of human nature are responsible for two experiments which, if not executed with scientific precision, have been conducted on a large scale. In this country and in Great Britain, four per cent. of children are illegitimate; in continental cities the percentage is as large as twenty and even forty. It is probable that these children have a physical heredity equal to that of the average child, but their social heritage is inferior, and their performance corresponds with their opportunity. If heredity were predominant there should be among our thousand leading men of science some forty of illegitimate parentage, whereas there are few or none. The mulattoes are by their physical heredity midway between the whites and the negroes, with parentage probably superior to the average in both races. But their social position is that of the negroes, and their per-

performance corresponds with their environment rather than with their heredity. There is not a single mulatto who has done creditable scientific work.

According to unpublished statistics which I have collected, 43 per cent. of our scientific men come from the professional classes who form one thirtieth of the population. Probably one half of them are sons of the one per cent. of the population most favorably situated to produce them. A child must be well born if he is to become a large figure in the world, but there may be tens of thousands of children born with the natural endowments of our productive scientific men who are given no opportunity to develop and use their ability for the benefit of society. A child with the exact constitution of Darwin born in China a hundred years ago would surely not have become Darwin. What chance would he have had in this country, or even in England, if his father had not been a man of wealth? The chief object of our educational system should be to select men and women for the work for which they are most fit. To train them for it is also important, but less so. In England one half of its men of performance have been educated at two universities having together some 6,000 students, nearly all from the dominant classes; one half of its cabinet ministers have come from a few interrelated noble families. It may be that there the object of the universities has been to train the privileged classes, of the trade schools to train artisans. Here the end of our schools is to break down, not preserve, the barriers of birth, to provide opportunity, not privilege.

Our democracy has not failed in its quantitative provision of education, but it has been backward in adjusting this education to its needs. In the elementary school, in the high school, in the conventional college, to a certain extent in the university with its professional schools, outworn traditions have persisted. The high school and college are in large measure traditional female seminaries of the kind that used to teach "Latin, logic and the use of globes." The colleges of liberal arts when women are excluded tend to unite the amusements and amenities of a county club with the frivolous amateurism and the futile scholasticism of its class-rooms. The schools of medicine and of law have been until recently trade schools of poor grade, proprietary institutions largely conducted for the indirect financial profit of the professors. Endowments are now being provided and standards are being raised, but there is something amiss in a system which does not permit a man to become self-supporting or to engage in his life's work until he is twenty-seven years old. If the cost of a physician's education must be $10,000, this money should be paid for those most competent to profit from it, not for those only whose parents happen to have so much money.

Nothing could be more undemocratic and anti-social than the plan of endowing—namely, compelling the people to support without the power to control—institutions where the sons of the newly rich may acquire the manners and prejudices of the leisure classes, and at the same time to conduct trade schools in order that there may be cheap skilled labor for exploitation. But the road to democracy may be paved with bad intentions. It is one of the ironies of history that the university endowed by wealthy and pious patrons for the education of the clergy and the upper classes, intended for the support of church and state, should by the nature of knowledge subvert the old orthodoxy and the old social and political system. It is safe to predict

that the trade school will do its share to break down the capitalistic regime.

In the charmingly worded address given by the then professor of jurisprudence and politics at the sesquicentennial exercises of Princeton University, the orator said:

I am much mistaken if the scientific spirit of the age is not doing us a great disservice, working in us a certain great degeneracy. Science has bred in us a spirit of experiment and a contempt for the past. It has made us credulous of quick improvement, hopeful of discovering panaceas, confident of success in every new thing. . . . I should fear nothing better than utter destruction from a revolution conceived and led in the scientific spirit. . . . Can any one wonder, then, that I ask for the old drill, the memory of times gone by, the old schooling in precedent and tradition, the old keeping of faith with the past, as a preparation for leadership in days of social change? . . . I have had sight of the perfect place of learning in my thought . . . calm Science seated there, recluse, ascetic, like a nun, not knowing that the world passes, not caring, if the truth but come in answer to her prayer; and Literature, walking within her open doors, in quiet chambers with men of olden time, storied walls about her, and calm views infinitely sweet; here "magic casements, opening on the foam of perilous seas, in fairy lands forlorn," to which you may withdraw and use your youth for pleasure; . . . its air pure and wholesome with a breath of faith; every eye within it bright in the clear day and quick to look toward heaven for the confirmation of its hope.

Fourteen years later the same speaker, with his ear to the ground, heard better voices:

The great voice of America does not come from seats of learning. It comes in a murmur from the hills and woods and the farms and factories and the mills, rolling on and gaining volume until it comes to us from the homes of common men. Do these murmurs echo in the corridors of universities? I have not heard them. (Speech to Pittsburgh alumni, April 17, 1910.)

It is he who listened to the voice of democracy who has been chosen to be its leader.

While it is proper to protest against the undemocratic survivals in the universities which we have inherited, the great services which they have rendered and now perform should not be forgotten. From the foundation of the universities of Salerno, Bologna, Paris and Oxford to the establishment of the Johns Hopkins, Stanford and Chicago, the university has been one of the principal factors in the advancement of science and in the progress of civilization. Three fourths of our productive men of science are now supported by universities. It is under the ægis of privilege and patronage that we have passed into the dawn of democracy. Our state universities are now assuming leadership, and should be counted with the public schools of which they are the head as our greatest contribution to educational progress and social welfare. The state university, directly responsive to the utilitarian democracy on which it depends, open to men and women on equal terms, selecting from all the people of the state those most fit for higher education and preparing them directly for their work in life, devoted in equal measure to teaching, research and public service, holds high the standard under which we move forward into the newer world.

There is a critical point in intelligence at which it is understood that education and productive science are the investments that pay the highest interest. This nation, thanks to the advances of science and to its natural resources, has the means to educate every child in the manner and to the extent that is desirable for the individual and for society. It has the wealth to make investments in scientific research to the extent that men can be found to carry on the work. The framers of the new income tax estimate that the superfluous personal incomes amount to over eight billion dollars annually, that is, the incomes which some 400,000 families possess beyond $4,000

a year. This would allow four billion dollars a year for scientific research and the conservation of health and $200 for each child beyond what is now spent on it. And why should not the money be so used? It would be the investment yielding the largest dividends. Those who spend $4,000 a year already consume four times the average amount. Some may contribute more than four times the average amount to society, but they do so owing to the opportunity and advantage which society has given them. Thanks to the social order, those spending $4,000 a year consume at least ten times as much as was possible for the average man a hundred years ago, and this possibility is due chiefly to the services of men now dead, most of all to those who advanced science and its useful applications. We can best reward them and honor their memory by using the wealth which they have created for further progress in the direction in which they led.

How long will it take to learn that the privileges of property are subordinate to the welfare of children? The average salary paid to teachers in the public schools of North Carolina is $199, of Pennsylvania $440, of California $817. The state of Pennsylvania spends on its entire educational system less than one tenth of the value of the coal it mines. When a state consumes its natural resources it should reinvest their entire value in education, scientific research and the public welfare. In 1880 forty per cent. of the teachers in our public schools were men; now the percentage is under twenty; in New England and in New York it is under ten. In Germany four fifths of the teachers are men. Why should ignorant and characterless girls be permitted to practise education on our children because they are cheap? If the salaries of teachers were doubled, some competent men would adopt the profession for a life work, and the best women could be selected, preferably those who had first cared for children of their own. The applications of science in the conservation of life and the production of wealth have entirely altered the position of women and of the family. In elementary schools the best teacher is the family—husband, wife and children together.

It is for the honor and ultimate welfare of Georgia that 25 per cent. of its population are children of school age, whereas only 17 per cent. of the population of New York and New England—probably less than 12 per cent. of their native population—are of this age. Since 1880 Georgia has increased its per-capita payment for public-school education sixfold; New York and New England have only doubled theirs. In the past twenty years New York and New England have not increased their expenditure enough to make up for the depreciation in the value of money. Georgia spends each year 6.3 mills on the assessed valuation of its real and personal property on public-school education, New York state 4.7 mills.[2] The south is bent under the inherited burden of slavery and civil war. But if it maintains its birth rate and cares properly for its children and its health, the center of wealth and civilization will return southward.

Over a billion dollars a year are spent in the United States on the drinking of alcohol and its consequences, a comparable amount on prostitution and its ensuing diseases. We devote twice as much money to each of these destructive agencies as to our entire educational work. Pleasure auto-

[2] Real estate is underassessed in Georgia. In New York personal property is scandalously understated, owing to the tax. Personal property in Massachusetts is valued at more than two thirds of the real estate, in New York at less than one twentieth.

mobiles or moving-picture shows cost each year more than the support of the teachers in all our schools. The national wealth is ample to double the salary of every teacher, from the negress in Georgia who receives $100 a year to the professor at Harvard who receives $5,000. The qualifications of the teacher should be as much above those of the lawyer and physician as they are now below them. The dentist who mends my children's teeth earns over $20,000 a year; the professors and instructors who teach them at the university receive salaries averaging about $2,000. Teaching can not be made the most honorable of professions by increasing salaries, but this is the easiest way to raise its standards. If we can bring into the work men of ability, they will promote the reforms that are needed. Teachers have inherited the status of domestic servants, and like domestic servants they should free themselves from personal subjugation. It may be that a hundred years hence the English suffragettes and the leaders of the I. W. W. will be counted among the world's reformers. But we can scarcely imagine that it will ever be looked back on as creditable that the salary and even the chair of a university professor should be dependent on the favor of a superior official, or that the educational authorities of our largest city should forbid the employment of married women as teachers; should permit a woman teacher to marry, but should discharge her if she bears a child.

Both the difficulties of state and endowed education and the possibilities of education in a democracy are exhibited by the performance of institutions such as the Scranton International School of Correspondence and Valparaiso University, which by the initiative of single individuals can compete successfully with all the resources of state support and private philanthropy. It is a triumph of democracy that such institutions are possible; it is a scandal of democracy that they exist. The same observation may be made in regard to our private universities and the corporations for research established by Mr. Carnegie and Mr. Rockefeller. It is a fine thing that private means should be so used; it is humiliating that the taxation of steel and kerosene and the use of the proceeds should be left to individual caprice instead of being attended to by the state. Monopolies by which it is possible to charge more for a service than it costs must be controlled or conducted by the state. In like manner services rendered not to an individual but to society must be paid for by society. The most important of these services are creation in science and the bearing and rearing of children. Their performance is dependent on fundamental instincts implanted for their use to the race rather than to the individual and liable to atrophy or perversion under the artificial conditions of contemporary rationalism.

Under oligarchic institutions scientific research may be a by-product of the leisure classes and may be rewarded by patronage and honors; the bearing of children may be encouraged by non-rational patriotic and religious sanctions. In a democratic society research should be paid for by the state and the cost of bearing, rearing and educating children should be shared equally by all. Apart from the individual joy and profit in living—whatever that may be—each youth twenty years of age not below the average in endowment is economically worth to the state at least $10,000 in that he will produce so much wealth in excess of what he will consume. The exceptional individual may be worth a hundred million dollars. It is the business of the state—its principal business—with one hand to provide for the advancement of the material sciences and the sciences concerned with human conduct, with the other hand to care

for the production of well-born children and their preparation for the work for which they are fit.

Existing conditions would be discouraging if they were a relapse from better things; but this is by no means the state of affairs. The defects of our system of education, our lack of distinction in science, art and letters, the shortcomings of our political and social institutions, are due in larger measure to the survival of standards and traditions from a predemocratic world than to the difficulties inherent in a democracy. We may complain of our simplicity and crudeness, of our waste and incompetence, of our selfishness and corruption, but this only means that human nature and human conduct are what they are. Montesquieu was doubtless correct in saying that virtue is the principle of democracy, but of what social or political system is it not the basis? In what other nation would the people respond to the call of the primitive virtues with so much alacrity as here under the leadership of men such as Mr. Roosevelt, Mr. Wilson and Mr. Bryan? While virtue is essential to a nation, intelligence is desirable. The state should not neglect the advancement of science and be content to provide a hereditary system of education handed down from generation to generation. The Chinese have learned better.

The way to improve our educational work is to make the career of the teacher such that the wisest men and women of the country may be drawn to it, and then to give them opportunity and encouragement to develop a science of education and to apply it. In our universities, especially in our state universities, we have laid the foundations. The national government in its land grants to colleges of agriculture and the mechanic arts, in its bureau of education and in other directions, has accomplished something, but not enough. The secretary of a department of education and science should be the ablest man in the country, the president only excepted. The federal government can make the most noteworthy advance by the establishment of a national university at Washington to coordinate the work of its departments, to advance science and education, to set standards to the states. The ideals of a people must be symbolized in institutions. To substitute a constitution for a crown is futile. The ideals of a democracy can best be embodied in a great national university. We should then join with other nations in the establishment of an international university.

It is clearly impossible in a forty-minute address to discuss the contents and methods, the objects and results, of education, from the kindergarten to the university, from the crib to the death-bed. It is exactly those subjects on which we are most ignorant that can be talked about most endlessly. I have not hesitated to express opinions on various occasions[3] and have indicated some of them in the course of these remarks. But my plea is that the time has now come when opinions, traditions and rule-of-thumb methods should yield to a science of education. Feeble infant as is this section of education of the American Association for the Advancement of Science, it has more promise of development than the best organized political party or the most richly endowed denominational church. It is the old story—"The harvest truly is plenteous, but the laborers are few." If we could only realize what it would mean to have a science of education, a science of health, a science of conduct, surely all the resources of our civilization

[3] For example, in three addresses published in *The Popular Science Monthly*, "Concerning the American University" (June, 1902), "The School and the Family" (January, 1909), and "The Case of Harvard College" (June, 1910).

would be turned in this direction. And they will be. The progress of the physical sciences in the nineteenth century will in the coming century be paralleled by advances in the psychological sciences. Science and education have given us democracy; it is the duty and the privilege of democracy to repay its debt by forwarding science and education to an extent not hitherto known in the world's history.

J. McKeen Cattell

THE PROFESSORSHIP OF PHILOSOPHY AND PSYCHOLOGY AT LAFAYETTE COLLEGE

At a largely attended joint meeting of the American Philosophical Association and the American Psychological Association, held at New Haven, December 31, 1913, the report of a committee appointed to inquire into the circumstances connected with the resignation of Dr. John M. Mecklin from the professorship of philosophy and psychology at Lafayette College was read and approved, *nemine contradicente*, and ordered printed. The committee was composed of Professors A. O. Lovejoy, of Johns Hopkins (*Chairman*), J. E. Creighton, of Cornell; E. Hocking, of Yale; E. B. McGilvary, of Wisconsin; W. T. Marvin, of Rutgers; G. H. Mead, of Chicago, and H. C. Warren, of Princeton. The report involves principles of general interest to American university teachers and administrators; and the more essential parts are, therefore, here reproduced at length.

The committee's understanding of the scope and purposes of its inquiry is set forth in its original letter to Dr. E. D. Warfield, president of the college:

The function of the committee is primarily to secure an authoritative statement of the facts in the case which can be laid before the members of the associations (of both of which Professor Mecklin is a member) at their approaching annual meetings, for their information. The concern of these bodies in the matter is twofold. They consist for the most part of members of the university teaching profession, and they are therefore anxious to ascertain the reason for any action which may have the effect of injuring the professional standing and opportunities of any of their own members. It would seem, in the second place, desirable that the members of these associations should know somewhat definitely what doctrinal restrictions are imposed upon teachers and investigators in philosophy and psychology in the principal American institutions of learning. Such knowledge it is important to our members to have, both in order that their action in making recommendations for positions and the like may be guided thereby, and also that in their judgment of the department of philosophy and psychology in any institution, they may bear in mind the predetermined limits of liberty of opinion which affect the tenure of professorships in that institution. It has been publicly asserted that restrictions of this kind obtain at Lafayette College.

In its attempt to secure the desired information the committee, of course, turns first to yourself and to Professor Mecklin. We shall therefore be greatly obliged if you will let us know whether the statements already published in Science and the *Journal of Philosophy* regarding the circumstances of Professor Mecklin's resignation seem to you accurate, and what your understanding is as to the doctrinal requirements imposed upon professors of philosophy and psychology at Lafayette. The points about which we especially desire to be informed are indicated by the accompanying questions; we shall be obliged if, as an aid to giving definiteness to any statement which the committee may prepare on the subject, you will cover these questions in the reply which we hope you will be good enough to let us have.

The appended questions were as follows:

1. Was the resignation of Professor Mecklin called for by the administrative authorities of Lafayette (*a*) because of certain doctrines held or taught by him; or (*b*) because of certain doctrines contained in the text-books used by him?

2. In either case, what, specifically, were the opinions or teachings to which objection was made?

3. Are the statements made by Professor Mecklin in *The Journal of Philosophy* of September 25, 1913, regarded by the administrative authorities of Lafayette College as giving a substantially accurate and sufficient account of the facts in the case?

4. Is subscription to any specified creed a requisite to appointment to a professorship in Lafayette College?

5. Are the professors of philosophy and psychology required, so long as they hold their positions,

to conform their teachings to any specified creed or doctrine?

6. If so, what is this creed?

7. Are similar requirements imposed upon professors of other departments, such as biology and geology?

8. In case of alleged deviation by any professor from the doctrinal standards of the college, by whose interpretation of these standards is such deviation determined?

To these inquiries the committee reports that it has been unable to secure any definite answers from the president of Lafayette. After a month's delay, a reply to the above letter signed by President Warfield, the president of the board of trustees and the chairman of the curriculum committee, was received; but it "could be construed by the committee only as a courteous declination to furnish the definite information desired." A subsequent letter from President Warfield "accentuated this declination." The first of these communications does, however, contain at least one statement which a member of the board of trustees formally declares to the committee to be "not in accordance with the facts." In spite of this refusal of information by the college administration, the committee secured a large mass of evidence from other sources—trustees, members of the faculty, and former students under Professor Meeklin—and arrived at certain conclusions bearing upon three general questions. The committee's findings upon each of these are in part as follows:

I. *What, before the present case arose, has been the accepted understanding as to the limits of freedom in philosophical and psychological teaching at Lafayette College?*

American colleges and universities fall into two classes: Those in which freedom of inquiry, of belief and of teaching is, if not absolutely unrestricted, at least subject to limitations so few and so remote as to give practically no occasion for differences of opinion; and those which are frankly instruments of denominational or political propaganda. The committee does not consider itself authorized to discuss the question whether the existence of both sorts of institution is desirable. If, therefore, the present case were one in which a teacher in a professedly denominational college had in his teaching expressly repudiated some clearly defined and generally accepted doctrine of that denomination, the committee would not feel justified in proceeding further with the matter. These associations should, in the committee's opinion, intervene in questions of this sort only for three ends: (1) To ascertain which institutions do, and which do not, officially profess the principle of freedom of teaching; (2) to ascertain, with a fair degree of definiteness, in the case of those institutions which do not, what the doctrinal limitations imposed upon their teachers of philosophy and psychology are; and (3) to call attention publicly to all instances in which, in institutions of the former sort, freedom of teaching appears to have been interfered with, or in which, in institutions of the latter sort, restrictions other than those antecedently laid down appear to have been imposed.

Upon the question whether Lafayette is to be classed with institutions of the first or second type, the committee finds a surprising measure of disagreement among officers, teachers and graduates of the college. Article VIII. of the college charter provides:

"That persons of every religious denomination shall be capable of being elected trustees, nor shall any person, either as principal, professor, tutor or pupil, be refused admittance into said college, or denied any of the privileges, immunities or advantages thereof for or on account of his sentiments in matters of religion."

In accordance with this clause of the charter, a trustee writes the committee as follows:

"I need not remind you that Lafayette College is not a theological institution, nor does it profess to teach or impose upon its teachers or students, any creed or doctrinal religious standards. . . . Whatever may be Dr. Mecklin's impression of the attitude of the president, so far as the trustees and faculty of the institution are concerned, I know of no policy or shaping thereof that in any way involves the recognition or inculcation of any sectarian creed, Presbyterian or otherwise, much less any particular type of Presbyterianism." This interpretation of the charter—which is obviously in harmony with its text—is evidently shared by other members of the board of trustees.

On the other hand, the testimony of some members of the faculty, and that of President Warfield and two trustees, is that there is a general assumption that the teaching of professors must be in harmony with the doctrinal standards of the Presbyterian Church. The General Catalogue

(1912–13) contains the following statement (p. 146):

"The aim of Lafayette College is distinctly religious. Under the general direction of the Synod of Pennsylvania of the Presbyterian Church, its instruction is in full sympathy with the doctrines of that body. At the same time religious instruction is carried on with a view to a broad and general development of Christian character, within the lines of general acceptance among Evangelical Christians, the points of agreement, rather than those of disagreement, being dwelt upon."

The last sentence would appear to indicate the understanding upon which Professor Mecklin accepted the call to the professorship of philosophy and psychology in 1904; he writes that he then and at all times recognized that his teaching, "as well as that of every other professor," was to be "in accord with Christianity in the broad Evangelical interpretation of that term."

Here, then, would appear to be three distinct views of the position and policy of the college: It is committed to no specific creed; it is committed only to the principles of "Evangelical Christianity"; and it is committed to the principles of the Presbyterian Church. The committee, for the rest of this report, assumes that substantially the last-mentioned view is to be taken as the answer to the first question,—that, in the words of a trustee, it has been "commonly understood that the teachings in such departments [*i. e.*, those of philosophy and psychology] are in general to be in harmony with the doctrines of philosophy usually taught and held in the Presbyterian Church." But the committee can not but think it highly undesirable that in any college a question of such importance should be left open to such divergent official answers; and it appears of doubtful legality that the prevailing practise in the matter should be in express contradiction with an unrepealed clause in the college charter.

II. The second question which the committee has endeavored to answer is: *What were the actual grounds upon which Professor Mecklin's resignation was asked for, and what do these indicate as to the doctrinal limitation imposed upon professors in philosophy and psychology under the present administration of the college?* Upon this the committee's findings are as follows:

1. No connected and altogether definite statement seems ever to have been formulated of the specific points in Professor Mecklin's teaching to which objection was made, or of the manner in which these were held to conflict with Presbyterian principles. A member of the board of trustees of the college, who was present at the meeting of the curriculum committee at which the matter was first brought forward, states that he was unable from the discussion at that meeting, or in any other way, to ascertain precisely on account of what charges as to doctrines held or taught by him Professor Mecklin was dismissed. This trustee writes that the accusations of erroneous doctrines or opinions made against Professor Mecklin at this meeting "were indefinite and as far as I am concerned remain so to this present time." Another correspondent conversant with the facts writes the committee that the president of the college simply asserted that "the doctrines set forth in certain text-books adopted by Professor Mecklin, viz., Angell on Psychology, Dewey and Tufts on Ethics, McDougall on Social Psychology, and Ames on the Psychology of Religious Experience, were a departure from the doctrines that had been taught in the college in previous years. No definite statement was ever made by the president to the board of trustees, so far as I recollect, of the exact teachings to which he made objections, other than the general objections to the text-books above mentioned, and a general and indefinite statement that the teachings of Professor Mecklin were not in harmony with the traditional teachings of the college in the department of philosophy. Previously to Professor Mecklin's occupying the chair of philosophy, the teaching in that department had for some years been by Presbyterian clergymen who devoted a portion of their time thereto, but did not undertake to present to the student any clearly defined system of philosophical instruction. Professor Mecklin undertook to introduce such a system of instruction, in line with other first-class educational institutions, some of which were well-known Presbyterian colleges, and used in connection therewith, among others, the text-books above mentioned. Some of his teachings as inferred from the said text-books were objected to by the president as contrary to the traditional teaching of the college on these subjects. The board of trustees did not pass upon the questions raised, although they discussed them, and there was a difference of opinion among them on the subject. Some of the trustees, feeling it desirable that a controversy of a religious or denominational aspect should be avoided, thought it wisest, in view of all the circumstances, to advise Professor Mecklin to resign rather than have the

discussion proceed to a vote, which might or might not have been in his favor." There seems, in short to be no general and clear understanding among the members of the board of trustees and the faculty of the college as to the precise doctrinal grounds upon which the president's insistence on Professor Mecklin's dismissal was based. It is the opinion of the committee that in no institutions, of whatever type, should a professor be compelled to relinquish his position for doctrinal reasons, except upon definite charges, communicated to him in writing and laid, with the supporting evidence, before the entire board of trustees and the faculty; and that it is unfortunate in any case of this kind that, even by agreement between the persons concerned, the matter should fail to be brought to an explicit issue before the responsible governing body of the institution.

The committee, however, reports that, so far as can be determined in the absence of definite charges, the president's original and decisive objection to Professor Mecklin's teaching was, in the words of another professor at Lafayette, "based upon Dr. Mecklin's use of the doctrine or theory of evolution in his discussion of the growth of religion."

The committee observes that "as a body it has no competency to discuss whether or not the doctrines and text-books in question are or are not in harmony with Presbyterian standards." With regard, however, to the restrictions now imposed at Lafayette the committee reports as follows:

The committee is forced to conclude that at Lafayette College at the present time tenure of the professorship of philosophy and psychology is, in practise, subject not only to the requirement that the teachings of the incumbent shall be in substantial harmony with the commonly accepted doctrines of the Presbyterian Church, but also to the requirement that his teachings shall be in substantial harmony with the theological opinions of the administrative authorities of the college, and with their interpretation of the philosophical implications of those opinions. The committee also concludes that the statement of the Lafayette College Catalogue, that the religious instruction there "is carried on within the lines of general acceptance among evangelical Christians, the points of agreement, rather than those of disagreement, being emphasized," is not accurately descriptive of the present policy and practise of the college. The committee further gathers from various evidence brought to its knowledge that the administration of the college disapproves of the mere presentation to the students, through text-books or collateral reading, of any philosophical views which it regards as seriously erroneous, and discourages instruction which has the effect, as Professor Mecklin's evidently had, of provoking thought and stimulating discussion and debate among the students upon philosophical and religious issues.

III. The third general question taken up by the committee concerns the attitude of the administrative authorities of Lafayette College towards the committee's inquiry. This attitude, as indicated above, was one of unwillingness to give the information asked for. Upon this the report makes the following comments:

It is true that President Warfield [in his last letter to the committee] gives as a reason for his refusal to make "a statement with regard to these matters" a formal request by "those who were recognized as speaking for Professor Mecklin" that "no information should be given out with regard to what took place before the board of trustees except that after the consideration of a report from the curriculum committee Dr. Mecklin offered his resignation which was accepted and that he was granted a year's salary." President Warfield thus represents his reticence as actuated, at least in part, by a deference to Professor Mecklin's wishes. Upon this matter Professor Mecklin makes the following statement to the committee: that no such request was made to the trustees by his authority, that, on the contrary, he regarded such a policy of secrecy about the causes and circumstances of his resignation as unfair to him and likely to be detrimental to his professional reputation; that he expressly informed a committee of the trustees which conferred with him that he desired no concealment of the grounds for the action taken; that he has publicly given evidence that such was his desire, by his letter on the case, published in *The Journal of Philosophy;* and that his wish that the facts should be fully made known has come within the knowledge of President Warfield. Your committee notes, also, that there was published in the Philadelphia *Public Ledger* of June 20, 1913, a long and circumstantial (though incomplete) statement (already referred to) by Dr. Warfield respecting Dr. Mecklin's resignation; it can not, therefore, be said that hitherto "no information" has been "given to the public with regard to what took place be-

fore the board of trustees," beyond that contained in the letter above cited. In view of these circumstances the committee finds itself unable to suppose that the decisive reason for President Warfield's reluctance to answer its inquiries is his consideration for the interests and wishes of Professor Mecklin. The committee notes, moreover, that two out of the three questions last laid before President Warfield asked for information, not about the resignation of Professor Mecklin, but about the general policy of the college and the specific credal requirements attaching to the professorship of philosophy and psychology. These inquiries, also, President Warfield has declined to answer. He intimates, indeed, that he regards it as improper for persons not connected with the college to ask, or for him to answer, "questions concerning the college or its members."

The attitude thus assumed does not seem to this committee one which can with propriety be maintained by the officers of any college or university towards the inquiries of a representative national organization of college and university teachers and other scholars. We believe it to be the right of the general body of professors of philosophy and psychology to know definitely the conditions of the tenure of any professorship in their subject; and also their right, and that of the public to which colleges look for support, to understand unequivocally what measure of freedom of teaching is granted in any college, and to be informed as to the essential details of any case in which credal restrictions, other than those to which the college officially stands committed, are publicly declared by responsible persons to have been imposed. No college does well to live unto itself to such a degree that it fails to recognize that in all such issues the university teaching profession at large has a legitimate concern. And any college hazards its claim upon the confidence of the public and the friendly regard of the teaching profession by an appearance of unwillingness to make a full and frank statement of the facts in all matters of this sort.

The report is published in full in the *Journal of Philosophy, Psychology and Scientific Methods* for January 29, 1914.

SCIENTIFIC NOTES AND NEWS

Dr. Calvin Milton Woodward, emeritus professor of mathematics and applied mechanics and dean of the school of engineering and architecture of Washington University, past president of the American Association for the Advancement of Science, of the board of regents of the University of Missouri and of the St. Louis Board of Education, died from apoplexy on January 12, aged seventy-seven years.

Sir David Gill, the distinguished British astronomer, for many years astronomer at the Cape of Good Hope, died on January 24, at the age of seventy years.

Colonel William C. Gorgas has been nominated to be surgeon-general of the army of the United States, with the rank of brigadier-general.

Dr. S. S. Goldwater has been appointed commissioner of health for New York City to succeed Dr. Ernst J. Lederle.

Charles W. Eliot, president emeritus of Harvard university, had been elected a trustee of the Rockefeller Foundation for the term of three years.

Dr. J. S. Haldane, reader in physiology at Oxford, has been chosen as Silliman lecturer at Yale University for next year.

The organizing committee, selected by the American members of the international committee of the Second International Eugenics Congress, has met in New York City and unanimously elected Dr. Henry Fairfield Osborn as president of the congress. Dr. Alexander Graham Bell was elected honorary president. The congress will be held in New York City near the end of September, 1915.

Professor Andrew C. McLaughlin, head of the department of history in the University of Chicago, was elected president of the American Historical Association at its recent meeting in Charleston, South Carolina.

At the recent annual meeting of the American Anthropological Association held in New York City, Professor Roland B. Dixon, of Harvard University, was reelected president; and Professors Franz Boas, of Columbia University, and George Grant MacCurdy, of Yale University, were designated to represent the association at the International Congress of Americanists, to be held in Washington, D. C., October 5 to 10, 1914.

WE learn from *Nature* that an institution of petroleum technologists has been formed in London with Sir Boverton Redwood, Bart., as president. Dr. D. T. Day, of the U. S. Geological Survey, and Professor C. Engler have been elected honorary members.

THE Geological Society of London will award its medals and funds as follows: Wollaston medal, Dr. J. E. Marr, F.R.S.; Murchison medal, W. A. E. Ussher; Lyell medal, C. S. Middlemiss; Wollaston fund, R. B. Newton; Murchison fund, F. N. Haward; Lyell fund, Rev. W. Howchin and J. Postlethwaite.

THE prizes in astronomy of the Paris Academy of Sciences have been awarded as follows: the Lalande prize to J. Bosler, for his researches on the sudden variations of terrestrial magnetism and their connection with disturbances in the sun; the Valz prize to Professor Fowler, for his researches in spectroscopy; the G. de Pontecoulant prize to M. Sundmann, for his researches on the problem of three bodies.

DR. ALEŠ HRDLIČKA, of the U. S. National Museum, has been named a titular member of the Société Impériale Des Amis D'Histoire Naturelle, D'Anthropologie et D'Ethnographic, Moscow, Russia.

PROFESSOR W. C. FISCHER, recently compelled to relinquish his chair at Wesleyan University, was a candidate for mayor of Middletown at a recent election, but was defeated by a vote of 699 to 689.

DR. CARL SKOTTSBERG, lecturer on botany and keeper of the herbarium at the University of Upsala and Dr. C. H. Ostenfeld, of the Botanical Museum at Copenhagen, have been visiting American botanical institutions.

As the first half of the Washington-Paris longitude campaign has been completed, the last few weeks have been devoted for the most part to exchange of observers. Mr. G. A. Hill and his party have returned to Washington, and the party headed by Professor F. B. Littell, U. S. N., has departed for Paris. The new French representatives are Professor E. Viennet, of the Paris Observatory, and Ensign P. Auverny, of the French navy.

NEWS has been received from Dr. William E. Farabee, who is now in Brazil directing the University of Pennsylvania Expedition in the Amazon regions. The expedition had passed through the territory inhabited by the Macusi Indians, and was starting, with forty porters, through the Wai Wai country into unexplored parts of French and Dutch Guiana.

DR. W. T. HORNADAY, director of the New York Zoological Park, will give a course of lectures as a part of the regular work at the Yale Forest School on wild animal life and its conservation. The titles of the five lectures in the course are as follows: "The Extinction of Valuable Wild Life," "The Feathered Allies of the Farmer and Forester," "The Legitimate Utilization of Wild Birds and Mammals," "Wild-animal Pests and their Rational Treatment," "The Duty and Power of the Citizen in Wild Life Conservation."

A COURSE in industrial organization and scientific management will be given at Brown University during the second semester of the present year. A feature of the course will be three or four lectures monthly by business men and efficiency experts. The first of these lectures, which will be open to the public, will be given on February 19 by Professor H. S. Person, director of the Tuck School of Administration and Finance, Dartmouth College, on "Different Types of Management."

ON January 8 Professor Theobald Smith delivered a lecture on "Prophylactic and Therapeutic Vaccines" before the New York State Veterinary College at Cornell University.

DR. ARTHUR L. DAY, director of the Geophysical Laboratory of the Carnegie Institution of Washington, lectured before the Geographical Society of Chicago on January 23 on "Some Observations on the Volcano Kileauea in Action."

MR. FRANCIS S. PEABODY, president of the Peabody Coal Company of Chicago, Illinois, recently gave a lecture before the college of engineering of the University of Illinois on "The Mining and Utilization of Illinois Coal." The lecture was illustrated with excel-

lent motion pictures taken underground in actual coal mines. They are the first successful motion pictures taken underground, and they give a vivid idea of the actual conditions met in coal mining.

On January 20, Professor W. Bateson began a course of six lectures at the Royal Institution on animals and plants under domestication. Beginning on January 22, Mr. W. McDougall gave a course of two lectures on the mind of savage men. The Friday evening discourse on January 23 was delivered by Sir James Dewar on "The Coming-of-age of the Vacuum Flask."

A memorial to Captain Scott will be unveiled on February 5 on the Col de Lautaret in the French Alps, whither the British explorer went in March, 1908, to make a trial of his motor sleighs.

John James Rivers, born in England on January 6, 1824, known for many years as a naturalist on the Pacific coast, died at his home in Santa Monica, California, on December 16, 1913.

The death has occurred, in his eighty-fourth year, of Mr. John Phin, the author of popular scientific books, and formerly editor of several New York technical papers.

The death is announced of Dr. A. F. Le Double, professor of anatomy at the School Médécine in Tours, France. Professor Le Double was an indefatigable worker and published a number of works of special value to anatomy and anthropology on the variations of the muscular system, of the bones of the skull, those of the face and those of the spine. Death overtook him in the sixty-sixth year of age and in the midst of preparation of further work on the variations of the human system.

The U. S. Civil Service Commission announces an examination for assistant in road economics, to fill a vacany in this position in the office of public roads, Department of Agriculture, Washington, D. C., at a salary of $1,500 a year.

The council of the Royal Geographical Society has made a grant of £1,000 towards the expenses of Sir Ernest Shackleton's transantarctic expedition.

Work has begun on the Magee Hospital for maternity cases at Pittsburgh to be erected at a cost of $800,000 provided by the late Christopher L. Magee as a memorial to his mother. The hospital is affiliated with the school of medicine of the University of Pittsburgh.

Messrs. Samuel and Harry Sachs, to perpetuate the memory of their parents, the late Joseph and Sophie Sachs, have given to Mount Sinai Hospital, New York, the sum of $125,000 to endow two neurological wards. The hospital will receive the sum of $100,000 under the will of Benjamin Altman and has received a $100,000 legacy from Mrs. Louis W. Neustader.

The Russian ministry of the interior has given consent to the free admission of Jewish members of the twelfth International Ophthalmological Congress, to be held at St. Petersburg from July 28 to August 2, but it limits the time they can stay in the country to September 15. In view of this restriction, Professor Julius Hirschberg, president of the Berlin Ophthalmological Society, has proposed that opthalmologists should refrain from attending the congress.

Marchese Raffaele Capelli, president of the tenth International Congress of Geography, has communicated to the U. S. Geological Survey, the following resolution adopted by the recent congress, on motion of M. Le General Schokalsky:

> The Tenth International Congress of Geography approves the impulse given to the project of an atlas of forms of terrestrial relief and the commencement of the execution of the work. It strongly recommends to all geographers and to the scientific institutions to aid this enterprise in every manner.

He requests that wide circulation be given to this resolution of the congress, in order to obtain cooperation on the part of the geographers of different countries.

In accordance with plans recently formulated by a special committee appointed by the secretary of agriculture whose recommenda-

tions have been approved by him, announcement is made of a general change to begin January, 1914, in the character of the *Monthly Weather Review* and the *Bulletin of the Mount Weather Observatory*. These two periodicals which have hitherto appeared separately (*i. e.*, the *Monthly Weather Review*, largely devoted to statistical data and notes on current weather conditions, and the *Bulletin of the Mount Weather Observatory*, embodying a portion of the research work done by the bureau) will be merged into a single publication. The new series will retain the former well-known title, *Monthly Weather Review*. It will contain contributions from the officials of the Weather Bureau engaged in research work of any kind bearing on the atmosphere, and its pages will be open also to others working along similar lines. It will not contain the detailed tables for the twelve large climatological districts that have appeared in the *Review* since July, 1909, but tables giving a general summary of the data from the "full reporting stations" of the Bureau, about 200 in number, will still appear as in the past. Beginning with January, 1914, the statistics now assembled to form these detailed tables for the twelve large climatological districts, defined by great watersheds, will continue to be assembled in tables similar to these, but will be arranged by states instead of districts. The tables for each state will form one report prepared at the section center of that state, except in the case of the New England States, which will appear as a single section; and Maryland, Delaware, and the District of Columbia will also be grouped into a single section. The total number of these sections will be 42. These detailed summaries by states will each contain from 8 to 12 pages of data and charts and will be issued from ten to twenty days after the close of each month; they will thus meet the need for prompt dissemination in each state of the information they contain better than is possible under the present policy of collecting them at the Central Office into a single monthly.

THE Russian empire, covering one seventh of the land area of the globe and only sparsely settled in spite of its nearly 170,000,000 inhabitants, offers an interesting subject for study for both business men and economics. This country to-day presents a picture of economic development comparable with that of the United States of three or four generations ago, in that Russia is now chiefly a producer of the raw materials derived from nature, such as grain, timber, hides and minerals, and is just beginning to develop manufacturing industries of importance. Its exports are almost entirely foodstuffs and raw and semi-manufactured products, while it imports nearly all of the higher grades of manufactures which its people require. The total value of the foreign trade of European Russia, in 1912, according to official figures, was more than $1,200,000,000, in which the United States participated to the extent of only $53,000,000. However, the indirect trade between the two countries passing through foreign middlemen brings the value of the sales of American products to Russia to $80,000,000, and the exports from Russia to the United States to $30,000,000. Largely owing to the lack of knowledge among American business men of the possibilities of the Russian market, the trade between the two countries is on the threshold only of its possible development. The monograph on Russia just published by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, entitled "Handbook on Russia," should therefore be of special interest. This book contains nearly 260 pages, with two maps, and includes a comparative description of the economic situation in European Russia, by Consul General John H. Snodgrass, stationed at Moscow; reviews of the commerce of various districts in 1912, by the American consuls stationed in Russia, and a very timely description of commercial and industrial conditions in Siberia, by Consul John Jewell, stationed at Vladivostok. To those who still regard that country as a frozen waste, the picture presented by Mr. Jewell will be a revelation. He compares Siberia to-day with Canada of a generation ago, and points out the possibili-

ties of great trade development that lie in the great natural resources of the country.

The committee appointed by the Paris Academy of Sciences to allocate the grants from the Bonaparte Fund for the year 1913 have, as we learn from *Nature,* made the following proposals: Out of sixty-three applications the committee recommends twenty-one grants.

3,000 francs to H. Caillol, for the publication of his catalogue of the Coleoptera of Provence.

2,000 francs to A. Colson, for apparatus required for his work in physical chemistry.

2,000 francs to E. Coquidé, to assist him in his study of the means of utilizing peaty soil.

2,000 francs to C. Schlegel, for the continuation of his researches in the laboratory of M. Delage.

6,000 francs, in equal parts, between MM. Pitard and Pallary, for assistance in the continuation of their scientific work in Morocco.

2,000 francs to Jules Welsch, for his geological work on the coasts of western France and Great Britain.

2,000 francs to Louis Roule, for continuing and extending his researches on the morphology and biology of the salmon in France.

2,000 francs to Jean Pougnet, for the continuation of his researches on the chemical and biological action of ultra-violet light.

2,000 francs to C. Dauzère for his work on cellular vortices.

2,000 francs to Méd. Gard, for the publication of a work and atlas on material left by the late M. Bornet.

4,000 francs to Aug. Chevalier, to meet the expense necessitated by the classification of the botanical material arising from his expeditions in Africa.

2,000 francs to Paul Becquerel, for the continuation of his physiological researches relating to the influence of radio-active substances upon the nutrition, reproduction and variation of some species of plants.

4,000 francs to Le Morvan, for assistance in publishing the photographic atlas of the moon.

2,000 francs to Jacques Pellegrin, to assist him to pursue his researches and publish works on African fishes.

3,000 francs to E. Rengade, for a systematic research on the presence and distribution of the rare alkali metals in mineral waters.

3,000 francs to Charles Alluaud, for the publication of work on the Alpine fauna and flora of the high mountainous regions of eastern Africa.

2,000 francs to Charles Lormand, for the purchase of a sufficient quantity of radium bromide to carry out methodical researches on the action of radio-activity on the development of plants.

2,000 francs to Alphonse Labbé, for researches on the modifications undergone by animals on changing from salt to fresh water or the reverse.

3,000 francs to G. de Gironcourt, for the publication of the scientific results of his expeditions in Morocco and western Africa.

3,000 francs to A. F. Legendre, for the publication of maps and documents of his expeditions in China.

2,000 francs to H. Abraham, for the determination of the velocity of propagation of Hertzian waves between Paris and Toulon.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board has given $750,000 toward an endowment of $1,500,000 for the medical department of Washington University, St. Louis, to create full time teaching and research departments in medicine, surgery, and pediatrics. The conditions of the gift provide that all teachers in these departments, while free to render any medical or surgical service, must not derive therefrom any personal gain. Their entire time must be devoted to hospital work, to teaching and research in their several specialties, as it is believed that medical education in the past has suffered from the fact that the teachers have had to rely on private work for the major portion of their income. The General Education Board has also made conditional grants of $100,000 each to Knox College, Galesburg, Ill., and to Washburn College, Topeka, Kan.

ANNOUNCEMENT was made at a meeting of the Yale Corporation on January 19 that gifts and pledges of $350,000 had been obtained for the development of the Yale Divinity School into a university school of religion. These gifts will increase the endowment of the school to over $1,200,000. Among the gifts were $100,000 from Mrs. D. Willis James and Arthur Curtiss James, of New Haven; $80,000 from Mrs. Stephen Merrell Clement, of Buffalo, N. Y., and an anonymous gift of $100,000, the latter to found a chair of social service.

THE trustees of Vassar College have announced that as President Taylor's resignation, which he presented a year ago, is to take effect February 1, in accordance with his wishes, and as no new president has been appointed, the administration of the college will be carried on by committees of trustees and faculty. Professor Herbert E. Mills, head of the department of economics, will act as chairman of the faculty.

ON January 9 and 10 occurred the first annual convention of the Stevens Institute of Technology. The convention opened with a symposium on "An Engineer's Part in the Regulation of Public Utilities." President Humphreys acted as chairman of the meeting, and papers were read by him and by several other Stevens alumni. Other features of the convention were the midwinter alumni meeting, a conference of Stevens Clubs, a trip to the Brooklyn Navy Yard and the alumni dinner at the Hotel Astor.

DR. E. A. FATH, director of Beloit College Observatory, has resigned his position to accept the presidency of Redfield College of Redfield, S. D. He will take up his new work about March 1.

DR. HENRY WINSTON HARPER, professor of chemistry in the University of Texas, Austin, has been made dean of the graduate department.

DR. CREIGHTON WELLMAN, dean of the school of hygiene and tropical medicine of the Tulane University of Louisiana, has resigned this position.

PROFESSOR F. L. STEVENS has resigned the position of dean of the College of Agriculture, Mayaguez, Porto Rico, to become professor of plant pathology in the University of Illinois.

DR. WILLIAM DUANE has been appointed assistant professor of physics in Harvard University. He has spent six years in the Curie Radium Laboratory at Paris, and last fall returned to this country as research fellow of the cancer commission of Harvard University. Professor Duane will devote the greater part of his time to the physiological action of radioactive substances and to the problems in physics directly conected with this subject at the Harvard Medical School and at the Huntington Cancer Hospital, but he will also undertake the direction of advanced students in problems on the purely physical side of radioactivity in the Jefferson Physical Laboratory.

DR. H. F. BAKER, F.R.S., fellow and lecturer of St. John's College, and Cayley university lecturer in mathematics, has been elected Lowndean professor of astronomy and geometry at the University of Cambridge in succession to the late Sir Robert Ball.

DISCUSSION AND CORRESPONDENCE

TUBERCULOSIS FOLLOWING TYPHOID FEVER

IN SCIENCE for 1908, Professor W. T. Sedgwick, of the Massachusetts Institute of Technology, called attention to the remarkable discovery by Reincke, of Hamburg, and Mills, of the United States, that when an infected water supply of a community was improved by filtration or otherwise, not only did typhoid fever diminish, but other diseases also, such as tuberculosis. Hazen calculated that for every typhoid death prevented, two or three were saved from death by other diseases. Sedgwick and MacNutt subsequently published their full paper in the *Journal of Infectious Diseases*, and the former in still another paper in a symposium on "Tuberculosis in Massachusetts," 1908, stated that as a rule infected waters increased the death rate from tuberculosis and purification of water decreased the rate.

For some time I have been collecting data which enable us to extend these generalizations still further. It has been found that tuberculosis follows typhoid fever far more frequently than physicians have suspected, and moreover the tuberculosis mortality curve of a nation is almost always parallel to that of typhoid fever. Cities do not show such a close agreement as the country as a whole, because consumptives quite commonly leave the city to die elsewhere. As far as the very defective statistics permit a conclusion, it is to the effect that consumptives have had much more typhoid fever than the rest of the population. We have long known of the serious after effects of typhoid fever, but only recently have a few physicians been calling attention to the far-reaching nature of these sequelæ. Tuberculosis is only one of these results. That is, by reducing typhoid fever in any way whatever we save far more from death by numerous other conditions due to the lessened resistance caused by the typhoid infection. The purification of a water supply is then only one of the numerous ways of reducing tuberculosis.

The explanation of the phenomenon is evident. By personal inquiries of physicians in the United States, Germany, Switzerland, France and Great Britain, I find that the following facts seem proved to the minds of those who by special study are competent to form an opinion. Babies are born free of tuberculosis, but begin to acquire it as soon as they can crawl around, pick up the bacilli with dust and dirt, and immediately convey them to the mouth after the manner of all babies. These germs are weakened or attenuated by sunlight, drying, etc., and are not able to spread actively, though they establish themselves. Those which are taken in by the phagocytes have the same effect as vaccination and cause the production of antibodies which make us all more or less immune to infection by virulent bacilli. If a baby is infected by fresh virulent bacilli from a nurse, before its immunity is produced, it dies of rapid disseminated tuberculosis, but an adult is not harmed by the virulent bacilli he takes in. Indeed, there is no incontrovertible evidence that any adult ever acquires tuberculosis. If one develops active tuberculosis, it is not a new infection, but an activation of latent lesions he has been carrying since childhood. Something has happened to him which has caused a temporary lessening of his antibodies and allowed the latent tuberculosis to spread—and nothing is more potent in doing this than the infections like measles, whooping cough and typhoid fever. Without these activating causes a man may lose immunity very slowly by improper food, mental and physical exhaustion, living in badly ventilated rooms, lack of outdoor exercise and a thousand other ways of lowering general health, but if one in such a condition does acquire another infection like pneumonia, typhoid fever or influenza, his chances of becoming actively tubercular later are very large. Post-mortems of children almost always reveal tubercle, no matter what the disease was which caused death. Post-mortems of adults always show healed lesions, proving that at some time in our lives each of us lost resistance sufficiently to allow the lesions to become active, though we were later cured by a reestablishment of the immunity. One eighth or one tenth of us are unable to reestablish it and perish from tuberculosis. The facts are bound to modify the anti-tuberculosis crusade most profoundly.

Savages, living an outdoor isolated life, have no chance to encounter tubercle bacilli and consequently do not become immune. When they do come in contact with a case they run a rapidly fatal course—generally if not always disseminated or miliary. That is, tuberculosis did not become a human affliction until long after we began to cluster together in confined shelters—possibly not until after we began to construct huts, "dugouts" and houses.

The detailed data which prove the relationship of tuberculosis and typhoid fever will appear in *American Medicine* in January, but this preliminary note is published as an answer to the questions of Hazen and Sedgwick as to how we could explain the phenomenon of a decrease of tuberculosis by the

simple expedient of purifying the water supply.

CHARLES E. WOODRUFF

SCIENTIFIC BOOKS

Lectures on the Differential Geometry of Curves and Surfaces. By A. R. FORSYTH. University Press, Cambridge, 1912. Large octavo. Pp. xxiii + 585. Price, $8.

Professor Forsyth's skill and versatility in the writing of mathematical treatises, already proved by his well-known works on differential equations and the theory of functions, is again illustrated by this new volume, his first in the field of geometry. The lectures were delivered, in substantially their present form, during the author's tenure of the Sadlerian professorship at Cambridge. They make very interesting reading. The style is graceful, and the technical discussions are illuminated by many passages on the history and development of the special topics considered.

Naturally no attempt is made to cover the whole field of differential geometry. Not even the classic four-volume treatise of Darboux pretends to include all the applications of the methods of the infinitesimal calculus to the domain of geometry. In particular, the author omits all extensions to hyperspace and non-Euclidean geometries. His main aim is to "expound those elements with which eager and enterprising students should become acquainted," and to provide such students, who, later, may devote themselves to original work "with some of the instruments of research."

The author restricts himself to curves and surfaces in ordinary Euclidean space and uses the direct methods introduced by Gauss. "I have made no attempt to give what could only have been a rather faint reproduction of Darboux's treatment, which centers round the tri-rectangular trihedron at any point of a curve or surface or system. My hope is that students may experience an added stimulus when they find that different methods combine in the development of growing knowledge." It must be admitted that, by showing the power of the more natural methods (combined, of course, with typical Cambridge skill in analytical manipulation) in the solution of extremely difficult problems, the author's procedure is amply justified.

As regards logical rigor the work is about on a level with the texts of Bianchi, Scheffers, and Eisenhart. No attempt is made to lay precise function-theoretic foundations for the geometric structure which is erected. In particular the concepts of analytic curve and surface, employed throughout the work, are never formulated precisely. Professor Study's vigorous criticism of the new edition of Bianchi in this aspect applies in fact to all standard treatises on differential geometry. It must be confessed that the claims of rigor are not emphasized in geometry to nearly the same extent as in analysis. In this respect geometry in fact occupies a position between analysis and physics, and to that extent belongs to applied rather than to pure mathematics. Study has himself outlined a proper basis for the treatment of analytic curves,[1] but this has not yet been digested into a form suitable for an introductory text, and the corresponding discussion of surfaces is still to be undertaken. No doubt, in the future—how near one can not say—Study's high and beautiful ideal will become realized. Meanwhile, most geometers, at least when they write on differential geometry, follow the older and what they considered the most expedient approach. Perhaps a distinction should be made, even in the domain of graduate mathematics, between *pedagogic* books and *logical* books. The evolution toward a rigorous treatment (never perfect, but at least up to the highest standard of a given period of mathematics) is obviously inevitable.

As regards the introduction of *imaginary* configurations in geometry the author follows the traditional half-hearted policy of considering them only when it is convenient, or at least traditional, to do so. Thus, in connection with a real surface, it is analytically expedient to introduce certain curves, of course imaginary, whose length (between any two points) is zero. [These the author desig-

[1] In two memoirs published in the *Trans. Amer. Math. Soc.*, 1909, 1910.

nates as *nul* lines, a very good name in itself, but already in use in an entirely different sense in connection with the so-called nul-system of statics and line geometry, and furthermore unnecessary since the term *minimal* lines is quite standardized in the literature.] Again in connection with the problem of geodesic representation, the usual discussion of the real solutions of Beltrami and Dini is followed by the imaginary solutions discovered by Sophus Lie. If then imaginary figures are allowed even when, as in this last instance, they are, however interesting, really inconvenient, why not, as Study advocates, introduce them deliberately and systematically?

The student usually gets the impression that whatever is true in the real domain, will, by some very nebulous principle of continuity, also be true in the larger complex (real and imaginary) domain. This is actually the case in a remarkably large number of questions, but certainly not in all. The exceptional character of minimal curves has long been recognized, but only recently the peculiar curves lying in a minimal plane have been investigated by Study and his students.

Even in the domain of curves lying in an ordinary (Euclidean) plane, the reviewer has recently encountered a striking instance of how imaginary figures may have essentially different properties from real figures. It is a standard theorem in elementary calculus that when one point approaches another on a curve the arc and the chord becomes ultimately equal, that is, the ratio of the arc to the chord approaches unity as its limit. This property of real analytic curves is true of most imaginary curves, as can be verified by calculation, but not of all. In the simplest class of exceptional imaginary curves, the limit is a certain irrational number, approximately .94. Thus the arc, instead of becoming equal to the chord, becomes *less* (of course in absolute value, since both arc and chord are complex quantities). Again, the statement is usually made that the difference between the arc and the chord is an infinitesimal of *third* order; but in the present instance it is in fact of the *first* order. The same class of curves shows that even when there is no cusp or singular point the radius of curvature may vanish. It is remarkable that whenever the limit mentioned is not unity, it is at most equal to .94. For space curves the result is quite different, since the limit may then be any number, real or imaginary.[2]

The moral of all this is that if, originally, imaginaries were introduced into geometry because they made the statement of propositions, especially of algebraic geometry, *easier*, and bore out the principle of continuity, we have to pay for this nowadays by a systematic treatment of the imaginary figures in complete generality. We must look, with an enlightened view, over the entire complex domain, instead of restricting our attention, from some more or less accidental motive, to some cross section connected, more or less closely, with the original real domain. Of course there will always be justification for a purely real geometry (as instanced say by analysis situs, or the geometry of connection, including the theory of knots); but differential geometry has been guided mainly by the theory of analytic functions (power series), rather than the theory of functions of a real variable, and the tendency toward a perfect correspondence with the former theory seems all-compelling. The present period is one of transition, and that is always hard on both the writer of text-books and his students.

The author has certainly succeeded in getting into one volume most of the more important standard topics. This is shown by the chapter headings: Curves in space, General theory of surfaces, Organic curves of a surface, Lines of curvature, Geodesics, General curves on a surface and differential invariants, Comparison of surfaces, Minimal surfaces, Surfaces with plane or spherical lines of curvature and Weingarten surfaces, Deformation of surfaces, Triply-orthogonal systems of surfaces, Congruences of curves.

The treatment of each of these topics is quite elaborate, in many instances the proofs are more elegant than those usually given, and an abundant selection of problems (many

[2] See *Bull. Amer. Math. Soc.*, Vol. 20, p. 727.

of them difficult, and often containing important results, as is to be expected of a Cambridge treatise) is included.

Perhaps the most important and interesting feature of the book is the long chapter dealing with differential invariants, covariants, and parameters. The algebraic method employed is due to Forsyth himself, and was first published in a memoir in the *Philosophical Transactions*, 1903. The calculations are arranged very ingeniously, and the detailed results are certainly useful. The geometric interpretations, however, are not always clear, and sometimes they appear to be only partly geometric. The practise of calling a result geometric when it is in fact semi-geometric and semi-algebraic is unfortunately rather prevalent.

The author's terminology, in this connection, can not be recommended. He speaks of the invariants of "a single curve," when he really means a *system* of curves, simply infinite in number. His results have in fact no meaning for a single curve. It would be absurd to imply that the author's ideas are not clear—it is merely a matter of careless terminology. The distinction between a *system of curves* and a *curve* is just as great as that between a *curve* and a *point*. Of course a system is made up of an infinitude of curves, just as a curve is made up of an infinitude of points, but that is no excuse for identifying the configurations.

The long list of invariants for "two curves" refers actually to two simply infinite systems of curves, a figure usually called a *net* of curves. The author is not here discussing doubly-infinite systems. It is best to avoid the ambiguous term double system: it refers sometimes to a double infinity (that is, infinity times infinity) and sometimes to two single infinities (that is, a net).

After the discussion of "one curvo" and "two curves," the rather mysterious statement is made that "we could not consider profitably more than two independent curves." As a matter of fact there are some very important (and naturally very difficult) problems connected especially with *three* systems, and, in the reviewer's opinion, the investigation will have to be extended.

Another more serious confusion of terms, and even of ideas, is prevalent in geometric literature. We refer to the distinction between a *system of curves* and a *parametered system of curves*. The latter object arises frequently in applications. For example, in a topographic map we have to deal not merely with the system of contour lines, but with the particular numbers attached to these curves indicating the heights above sea level. The same system of curves with different numbers would represent a different topography. In most discussions in geometry we are concerned merely with the system of curves; but if the attached numbers or parameters are also of significance, as they often are, the compound object should be called not a system, but a parametered system.

Even in one dimension an analogous distinction is important. A curve consists of a single infinity of points: if the points are labeled with numbers, then we have a new figure, a *parametered curve*. A straight line with a logarithmic scale is certainly different from a straight line with an ordinary uniform scale. A correct and well developed terminology is at hand in, for example, d'Ocagne's *Nomography*. This branch of mathematics was originated and developed almost entirely by engineers (mainly the French school), rather than pure mathematicians, but it is certainly time for writers on geometry to take advantage of their work.

With this terminology, it is possible to state very compactly a fundamental theorem in the theory of functions of a complex variable, as follows: Any (analytic) parametered curve can be converted into any second parametered curve by a unique direct (and a unique reverse) conformal transformation. This is true of parametered curves but not of curves: any curve can be converted into a second curve by an infinitude of conformal transformations.

The author is to be commended for not confining himself, as much as most writers do, to questions of first and second order (of

geometric infinitesimals). Third order questions have been treated in a haphazard way in the standard literature. Even in the simple case of plane curves, the average student becomes familiar only with the interpretation of the first derivative as slope (tangent line), and of the second derivative as curvature (osculating curve). As regards the third derivative, his mind is usually blank. Even the elementary books should contain the definition of *deviation*, introduced by Transon over seventy years ago.

An excellent index and table of symbols will be appreciated by the student, and make the volume serviceable for convenient reference. The press work throughout is quite perfect.

Edward Kasner

Columbia University

A Catalogue of the Fishes of Japan. By David Starr Jordan, Shigeho Tanaka and John Otterbein Snyder. Journal of the College of Science, Tokyo Imperial University, Vol. XXXIII., article 1. Tokyo, 1913. 8vo. Pp. 1–497, with 396 text-figures.

Japan possesses a wonderfully rich fish fauna. This is due to several causes: first, to the fact that she consists of a chain of islands with innumerable small, sheltered bodies of water which afford great variety of depth, physical condition of sea floor, etc.,—factors highly favorably to a diversity of fish life. Secondly, to her remarkable north-and-south extent, which gives her in addition to the regular north temperate fauna, in itself unusually rich in this instance, a subtropical fauna allied to that of the Philippine Islands, in the south, and a fauna merging into a subarctic one, in the extreme north. Thirdly, her eastern coast is touched by the *Kuroshiwo*, or warm black current, which harbors many tropical forms, some of them exceedingly rare, or in fact, only known from this current.

With such remarkable conditions, it is not surprising that ichthyologists should have been attracted to the study of Japanese fishes. Many of the writers of this and the preceding generation have taken a hand in describing portions of this fauna as materials were brought from Japan, so that an extensive literature has grown up about it. And there has been at least one extensive work on this fauna—that of Temminck and Schlegel, in two superb folio volumes, one of text and one of plates, published between 1842 and 1850.

But an entirely new chapter in Japanese ichthyology was opened when, in 1900, Chancellor Jordan and Professor Snyder, of Leland Stanford University, visited Japan for the purpose of studying the fishes. As a result of the collections then made, and of others made subsequently, including one by Gilbert and Snyder in the *Albatross*, in 1906, Jordan and his associates Gilbert, Snyder, Starks, Richardson, Fowler, Herre, Seale and Thompson, have worked unremittingly on this fauna, publishing paper after paper, until a long series, numbering several score, has now appeared. They have described hundreds of new species; figured, revised, re-studied, and thrown light on many of the darker problems relating to the fishes of Japan.

Early in the course of these studies it became patent to Jordan and Snyder that it was necessary to take stock of what had already been done on the Japanese fauna. Accordingly, in 1901, they published "A preliminary check-list of the fishes of Japan." This incorporated all the data then available, including two lists published by Japanese ichthyologists. The number of species listed was 686, many, however, only doubtfully referred to Japan. And now we have a new catalogue of the fishes of Japan from the pen of Jordan, Tanaka and Snyder. An idea of the enormous wealth of the Japanese fish fauna, as well as of the great stride that has been made in its study in a little over a decade, is shown in the fact that the present catalogue lists no less than 1,236 species (including the 6 given in the Additions and Corrections, pp. 429–430), or nearly twice the number known in 1901.

The catalogue—or check-list, as it might more correctly have been termed—enumerates the families, genera and species of the fishes occurring in the waters of Japan. Under each species is given a reference to the first describer, and generally, to a reviser; together

with the geographical distribution and one or more local Japanese names. Nearly one third of the species—396, to be exact—are illustrated, the admirable figures which have appeared in the publications of Jordan and his associates being reproduced. An excellent index to genera, species and Japanese names, covering 64 pages, greatly enhances the usefulness of the work. (This index, by the way, contains a number of misspellings—for instance, of *Scapanorhynchus, Etmopterus*, etc.).

A critic might perhaps find fault with the retention of a few superseded names, such as *Mitsukurina* for *Scapanorhynchus*, when it has been fairly well established that the former is identical with the fossil sharks which have long been known under the latter name; or with the omission of certain desirable references, to show that *Zameus*—to mention but a few instances—is a synonym for *Scymnodon, Deania* a synonym for *Centrophorus, Etmopterus frontimaculatus* probably a synonym for the Mediterranean *Spinax pusillus*,[1] etc. But in answer to such criticisms it may be said that the present list was obviously intended as a mere stock-taking of all the species that have been proposed, to serve as a basis for future work on the fishes of Japan; that it was not the purpose of the authors to give complete synonymies; and that these matters will be dealt with in the revisions of the various groups now being published by Jordan and his associates in America, or in the monograph by Tanak, which is appearing in part in Japan. Altogether the catalogue is carefully compiled, and will be invaluable to all students of the fishes of Japan.

The work was seen through the press by Dr. Shigeho Tanaka, lecturer in zoology in the Imperial University of Japan, and a co-author of the present work; and to him are due the thanks of all who will profit by this volume, for the great care he has exercised in guarding against typographical errors in the text.

L. HUSSAKOF

AMERICAN MUSEUM OF NATURAL HISTORY

[1] See C. Tate Regan, "A Synopsis of the Sharks of the Family Squalidæ," *Ann. Mag. Nat. Hist.*, 8 ser., II., 1908, pp. 39–57.

Pflanzenmikrochemie. Ein Hilfsbuch beim mikrochemischen Studium pflanzlicher Objekte von Dr. O. TUNMANN, Privatdozent an der Universitaet Bern. Ein Bd., pp. 631, mit 137 Abbildungen im Text. Verlag von Gebrueder Borntraeger, Berlin. 1913. M. 18.50.

That of the writing of books there is no end is one of the few biblical quotations which even the average freshman in college will recognize. Moreover, the graduate student in science, when sent to the library for references, is apt to wish that there might be fewer books for him to consult. Yet it is with a peculiar delight that the phytochemist witnesses the renewed literary activity in his particular field of research. Synthetic chemistry had so completely overshadowed phytochemistry for a generation and more since the days of Kekulé's structural theories, that the phytochemist is once more beginning to feel that his particular aspect of chemical research is again coming to its own. With a general treatise such as that by Haas and Hill, with staetter and Stoll on chlorophyll, and with the volume on a special method of phytochemical technique like the one before us, all within less than a twelve-month, this unusual productivity must certainly be regarded as the heyday of phytochemical literature.

The general part of Tunmann's tome is devoted to the technique of microchemical research as applied to plants and covers sixty-three pages. Of the special part sixty-six pages are devoted to inorganic chemistry. Hence the bulk of the volume is devoted to the organic microchemistry of plants.

Inasmuch as this is the first general survey of its kind since the "Botanische Mikrotechnik" by Zimmermann made its appearance in 1892, one may gladly welcome an up-to-date treatise on this subject. Even the person who is not well acquainted with the work that has been done during the past few decades in this particular field, will be struck by the innumerable references to special "Arbeiten" with which the pages abound. The pharmacist in particular will be gratified

to see to what extent the pharmacognosist and pharmaceutical chemists have contributed to make the microchemistry of plants an important branch of phytochemical investigation, pure as well as applied.

It ought to be possible in the future to supplement the macrochemical investigation of plants in a manner that should prove productive of the very best results. If the microscope, supplemented by accessories and chemical reagents, is going to enable the phytochemist of the future to extend the macroscopic examination carried out on one or several species to all members of a genus or even family with a minimum of material and possibly of time, the boundaries of plant chemistry ought to be extended farther in a decade than they have been during a century.

E. K.

THE ORIGIN OF CLIMATIC CHANGES[1]

THE discussion of meteorological observations shows clearly that climates undergo variations of short duration, but such records as the presence of old lake beaches and the existence of well-marked glacial moraines, and other geological evidence distinctly point to climate changes covering long intervals of time. The evidence is not sufficient to characterize the variations as periodic, but the ice ages are sufficient to point to times when the conditions reached were extreme.

What may reasonably be assumed to be the chief established facts about such extensive changes may be summed up briefly as follows: Climatic changes were several, and probably many. Similar simultaneous changes occurred over the whole earth, or, in other words, it was warmer or colder over the whole earth simultaneously. These times of warmth or coldness were unequal in intensity and duration, and of irregular occurrence, and, lastly, they have taken place from very early, if not from the earliest geological age down to the present. Numerous theories, both probable and improbable, have been suggested from time to time to account for the origin of such world-wide changes, and while each has its advocates, perhaps only three may be said to claim attention to-day. These may be briefly stated as the eccentricity theory (Croll), depending on the eccentricity of the earth's orbit; the carbon dioxide theory (Tyndall), based on the selective absorption and variation in amount of carbon dioxide; and thirdly, the solar variation theory, on the assumption of solar changes of long duration. A new theory, which may be called "the volcanic dust and solar variation theory," has recently been put forward by Professor W. J. Humphreys,[2] under the guarded heading, "Volcanic Dust and Other Factors in the Production of Climatic Changes, and Their Possible Relation to Ice Ages."

The author carefully points out that the idea that volcanic dust may be an important factor in the production of climatic changes is not new, but "though just how it can be so apparently has not been explained, nor has the idea been specifically supported by direct observation." He remarks also that while the pioneers regarded the presence of volcanic dust in the atmosphere as an absorbent of radiation, and so lowered the earth's temperature, modern observation suggests the opposite effect, namely, the warming of the earth's surface.

In putting forward his views of the action of dust, Professor Humphreys proceeds first to indicate that the dust that is effective is that which is situated in the atmosphere in the isothermal region or stratosphere. He then enters into the question of the size of the particles and probable time of fall, and concludes that particles of the size of 1.85 microns in diameter would take from one to three years to get back to the earth if they originally had been thrown up by a volcanic eruption.

Considering next the action of the finest and therefore most persistent dust on solar radiation, he finds that the "interception of outgoing radiation is wholly negligible in com-

[1] From *Nature*.

[2] *Journal of the Franklin Institute*, August, 1913, Vol. CLXXVI., No. 2, p. 131; also *Bulletin of the Mount Weather Observatory*, August, 1913, Vol. VI., Part 1, p. 1.

parison with the interception of incoming solar radiation."

Professor Humphreys now turns his attention to the observational evidence of pyrheliometric records, such readings being functions of, among other things, both the solar atmosphere and the terrestrial atmosphere. He thus introduces a curve showing smoothed values of the annual average pyrheliometric values, and compares this with sun-spot frequency values (representing solar atmospheric changes) and number of volcanic eruptions (representing terrestrial atmospheric changes). The similarity of the last-mentioned with the pyrheliometric curve leads him to write as follows: "Hence it appears that the dust in our own atmosphere, and not the condition of the sun, is the controlling factor in determining the magnitudes and times of occurrence of great and abrupt changes of insolation intensity at the surface of the earth."

The action of the dust intercepting at times as much as one fifth of the direct solar radiation leads him to inspect earth surface temperature values to inquire whether they are below normal on such occasions. The pyrheliometric and temperature curves suggest a relationship, but, as he states, "the agreement is so far from perfect as to force the conclusion that the pyrheliograph values constitute only one factor in the determination of world temperatures." A better agreement is secured when the combined effect of insolation intensity and sun-spot influence is considered.

The author then discusses the temperature variations since 1750 as influenced by sunspots and volcanic eruptions, and indicates that the disagreement in the curves of temperatures and sun-spots is in every important instance simultaneous with violent volcanic eruptions.

Limitations of space will not permit us to remark on his references to the action of carbon dioxide in slightly decreasing the temperature or to probable great changes in level. Enough perhaps has been said to show that Professor Humphreys, in his interesting attempt to show "that volcanic dust must have been a factor, possibly a very important one, in the production of many, perhaps all, past climatic changes . . .," has restarted a topic which will no doubt call for criticisms and discussions from many quarters.

SPECIAL ARTICLES

THE EFFECT OF COLD UPON THE LARVÆ OF TRICHINELLA SPIRALIS

In the course of an investigation relative to *Trichinella spiralis*, it has been determined that cold has a decided destructive effect upon the encysted larvæ of this parasite. Heretofore it has been accepted as an established fact, upon the basis, however, of insufficient evidence, that low temperatures have no considerable influence upon the vitality of the larvæ of *Trichinella*. Although the results of only a single series of the writer's experiments are available at present, these results have been so definite that there can be little doubt as to the lethal action of cold upon *Trichinella* larvæ. The writer's experimental work thus far has shown that most of the parasites survive when exposed for as long as six days to a temperature ranging between 11° and 15° F. (= − 11.70° to − 9.4° C.). On the other hand, when exposed to a temperature in the neighborhood of 0° F. (= − 17.8° C.) the larvæ of *Trichinella* quickly succumb. Only one out of over 1,000 larvæ examined has been found to survive an exposure of six days to this temperature. This was one among 275 isolated from a piece of trichinous meat which had been kept at a temperature of about 0° F. from September 27 to 30, allowed to thaw, and then again kept at the same low temperature, October 1 to 4, a total of six days' exposure. None was found alive among 498 larvæ from a piece of trichinous meat kept at about 0° F. September 27 to 30, allowed to thaw, then exposed again to the same low temperature October 1 to 3, and thus exposed five days in all, nor was any found alive among 233 larvæ from a piece of trichinous meat kept continuously at about 0° F. for five days. Out of 301 larvæ from trichinous meat kept at about 0° F. for three days only 5 showed signs of life. 225 out of 366 larvæ exposed for two days to a

temperature of about 0° F. were dead, and many of the remaining 141 showed only faint signs of life.

Results similar to the above were obtained from tests of trichinosed meat on guinea-pigs. Guinea-pigs fed with infested meat after its exposure to a temperature of about 0° F. for two, three, six and seven days, respectively, showed no trichinæ when killed and examined three weeks after feeding. A guinea-pig fed with meat from the same source which had been kept at a temperature of 11° to 15° F. for six days showed trichinæ when killed and examined three weeks after feeding.

It is evident that the results of these experiments, if confirmed by further investigation, are likely to be of great practical importance. Trichinosis in man is a very painful, frequently fatal, disease, and moreover it is comparatively common. Roughly estimated there have been recorded in the medical literature of this country about 1,200 cases of trichinosis, of which about 200 resulted in death. These figures undoubtedly include only a fraction of the cases which actually occur. Many cases of trichinosis recognized as such are not reported, and there is good reason to believe that the vast majority of cases are unrecognized, commonly passing as rheumatism, atypical typhoid fever, or as some other disease of uncertain nature. Some years ago Williams at Buffalo reported that he had found the parasite in 27 out of 505 cadavers examined for its presence, death in no instance having resulted from trichinosis. If Williams's findings be assumed to be statistically adequate, it may be concluded that five persons out of every 100 among the population typified by the 505 cadavers examined by him suffered from trichinosis at some time in their lives and recovered, in addition to which an indefinite number died of the disease. An extensive examination of cadavers throughout the United States would be required before general conclusions as to the prevalence of the parasite could be reached, but the numerous reported cases and Williams's figures are sufficient to prove that *Trichinella spiralis* is of common occurrence in man in this country. The prevalence of the parasite in man of course depends upon its prevalence in hogs and the extent to which uncooked pork is used as food. The microscopic inspection of over 8,000,000 hogs in this country during a period of nine years showed that 1.41 per cent. were infested with living trichinæ, in addition to which there were 1.16 per cent. containing trichina-like bodies or disintegrating trichinæ, or a total of 2.57 per cent. The custom of eating raw pork is not unusual among the population of the United States as evidenced by the large quantities of various pork products intended to be eaten raw that are prepared by meat-packing establishments. Incidentally it may be noted that the consumption of such products seems to be increasing from year to year. In view of the frequent occurrence of trichinæ in hogs and the not altogether rare practise of eating raw pork it is not surprising that trichinosis should be a rather common disease in the United States. Inasmuch as warnings against the eating of raw pork seem to have little effect in discouraging this dangerous custom, certain countries in Europe have tried at great expense and not altogether successfully to guard the consumer by means of a system of microscopic inspection.

In this country microscopic inspection of all the hogs slaughtered under Federal supervision would require an expenditure of probably not less than $5,000,000 per year over and above the sum already expended for federal meat inspection. Apart from other difficulties and objections of various sorts, the matter of expense alone is a serious difficulty in the way of a general trichina inspection, and as yet the federal government has not attempted such an inspection. In recent years, however, there has been some consideration of the question of a partial trichina inspection; that is, a microscopic inspection of those hogs slaughtered under federal supervision which are intended to be used in the manufacture of pork products of kinds customarily eaten raw. Such an inspection though it would by no means remove the danger, because even the best inspection is essentially imperfect, would greatly reduce the risk involved in the eating

of raw pork products, though, perhaps, on the other hand, it would tend to encourage the custom of eating raw pork among those persons who knew of the existence of a trichina inspection and of its purpose, and thus the good the inspection did in one way would be largely offset by the evil it did in another. The protection afforded by such an inspection would of course apply only to those pork products prepared under federal supervision and would not extend to products prepared in local establishments, or in private homes, even though the pork used came from animals slaughtered in inspected establishments, inasmuch as the special inspection for trichinæ would be given only to those hogs which were expressly intended to be used in the preparation of products of kinds customarily eaten raw. Nor would such an inspection afford any protection from the danger of contracting trichinosis through imperfectly cooked pork, as hogs not intended to be manufactured into products customarily eaten raw would not be inspected for trichinæ. The partial inspection in question, however, would cover the class of pork which seems particularly likely to be the most fertile source of trichinosis in so far as meats originating from establishments under federal inspection are concerned, and the consumer of raw pork products would thus be protected in large measure so long as he limited himself to those products specially labeled as inspected for trichinæ.

The results of the experiments recorded in this article naturally suggest the possibility of substituting refrigeration for microscopic inspection as a prophylactic measure. It is perhaps rather venturesome to express an opinion at the present time as to the extent to which refrigeration might be used practically as a preventive of trichinosis, but, if it be granted that it is desirable to institute measures which will serve to protect the consumer of raw pork products, leaving out of consideration the question of a general microscopic inspection of all hogs slaughtered, it seems to the writer, in view of the defects inherent in microscopic inspection even at its best, that refrigeration (provided the data at present in hand are confirmed by further investigation) promises to afford a means of preventing trichinosis of far greater certainty, easier to apply, and less expensive than any method of trichina inspection yet devised. Instead of a microscopic inspection of the hogs from which raw pork products were to be prepared there would be required simply the refrigeration of the pork at a certain temperature for a certain length of time. It is possible, considering that the refrigeration of foods is becoming more and more general, keeping pace with the development of improved and more economical methods, that sooner or later the general refrigeration of pork, without reference to whether it is to be eaten raw or cooked, may become desirable and feasible as a prophylactic measure against trichinosis. For the present, however, it is probable that the use of refrigeration for this purpose is likely to have only a more limited application such as that which has been suggested, leaving for future development its possible further extension, all of which is of course contingent primarily upon the confirmation of the results of the experimental work recorded in this paper, and secondarily upon various other things, such as the effects of refrigeration upon the meat and the expense involved in the artificial production of cold.

Further investigation of this interesting question of the effect of cold upon trichinæ is in progress, and it is hoped that conclusive data as to the exact temperatures and time required to render trichinous meat innocuous will be available at an early date.

B. H. Ransom

Bureau of Animal Industry,
U. S. Department of Agriculture,
Washington, D. C.

November 22, 1913

THE AMERICAN PHYSIOLOGICAL SOCIETY

The 26th annual meeting of the American Physiological Society was held at the University of Pennsylvania and at the Jefferson Medical School, Philadelphia, December 28–31, 1913. One hundred and eighteen of the members of the society were present at the meeting. This, I think, was

the largest attendance in the history of the society. This large attendance was due, in part, to the fact that the societies representing the biochemists, the pharmacologists, the experimental pathologists, the anatomists, the zoologists and the naturalists met in Philadelphia at the same time. This is a most excellent plan, and should be made a fixed policy of the biological societies. The members of all the biological societies had joint dinners and smokers the three evenings of the meeting.

Two of the scientific sessions of the Physiological Society were joint meetings with the Biochemical and the Pharmacological societies. The scientific program was as usual a lengthy one and comprised a number of papers of unusual importance. The number and general high grade of the demonstrations was also a feature of the meeting. The following is a list of the scientific communications:

"Phlorhizin Glycosuria before and after Thyroidectomy," by Graham Lusk.

"Studies in Diabetes: (1) The Effect of Different Compounds on Glycogenesis; (2) The Mechanism of Antiketogenesis," by A. I. Ringer and E. M. Fraenkel.

"Some Problems of Growth: (*a*) The Capacity to Grow; (*b*) The Rôle of Amino Acids in Growth," by L. B. Mendel and T. B. Osborne.

"Further Studies in the Comparative Biochemistry of Purine Metabolism," by Andrew Hunter.

"Changes in Fats during Absorption," by W. R. Bloor.

"Immunization Against the Anti-coagulating Effect of Leech Extract," by Leo Loeb.

"Anaphylaxis in the Cat and Opossum," by C. W. Edmunds.

"Vividiffusion: Report on Preliminary Results," by J. J. Abel, L. S. Rowntree and B. B. Turner.

"A Method of Dialyzing Normal Circulating Blood and Some of Its Applications," by O. L. V. Hess and H. McGuigan.

"A Biological Test for Iodin in the Blood," by A. Woelfel and A. L. Tatum.

"Further Studies of the Excretion of Acids," by L. G. Henderson and W. W. Palmer.

"Studies on Blood Plates," by T. F. Zucker.

"The Condition of the Blood in Hemophilia," by W. H. Howell.

"Some Physiological Factors Affecting the Coagulation Time of Blood," by W. B. Cannon and W. L. Mendenhall.

"The Action of Epinephrin on the Heart," by J. A. E. Eyster.

"Two Types of Reflex Fall of Blood Pressure," by P. G. Stiles and E. G. Martin.

"Dicrotism and the Brachial Flow Pulse (with lantern demonstrations)," by A. W. Hewlett.

"The Periodic Cardio-vascular and Temperature Variations in Women," by Jessie L. King.

"Acceleration of the Heart in Exercise," by H. S. Gasser and W. J. Meek.

"On the Constancy of Blood Pressure and Vasomotor Reactions in the Anesthetized Dog," by R. G. Hoskins and H. Wheelon.

"The Relative Systolic Discharge of the Left and the Right Ventricles," by A. L. Prince.

"The Effect of Vagal Stimulation on the Location of the Pacemaker of the Mammalian Heart," by W. J. Meek and J. A. E. Eyster.

"The Effect of Pulsation on Filtration," by R. A. Gesell.

"The Action of Pilocarpin on the Cerebrospinal Fluid," by F. C. Becht.

"The Osmotic Properties of Clam's Muscle," by E. B. Meigs.

(*a*) "Sources of Surface Tension in Striated Muscle," (*b*) "Maximum Surface Tension in Striated Muscle," by W. N. Borg.

"Some Characteristics of Mammalian Muscle," by F. S. Lee.

"Some Results Obtained by the Use of Quantitative Faradic Stimuli in Physiological Investigation," by E. G. Martin.

"Faradic Stimuli: A Physical and Physiological Study," by J. Erlanger and W. E. Garrey.

(*a*) "The Metabolic Gradient in the Nerve Fiber," (*b*) "The Action of Anesthetics on the CO_2 Production in the Nerve Fiber," by S. Tashiro.

"Proof that the Propagation of the Nervous Impulse Obeys the Laws of Propagation of Electricity along Conductors with Distributed Capacity," by A. C. Crehore and H. B. Williams.

"Saline Perfusion of the Spinal Centers in Frogs: The Effect of Calcium and Potassium Chloride," by R. D. Hooker and S. O. Reese.

"Variations in the Reflex Responses through Medullary Centers," by H. C. Jackson and E. M. Ewing.

"Evidences in the Cerebral Cortex of Mental Equipment and Intellectual Development," by E. L. Mellus.

"The Influence of Surroundings on Foveal Vision," by P. W. Cobb.

"The Effect of Strychnin on Reflex Thresholds," by E. L. Porter.

"The Influence of the Vagi on Renal Secretion," by R. G. Pearce.

"Stimulation of the Semi-circular Canals," by F. H. Pike.

"Demonstration of Vividiffusion," by J. J. Abel, L. G. Rowntree and B. B. Turner.

"The Determination of Blood Sugar," by P. A. Shaffer.

"Intestinal Peristalsis in *Homarus*," by F. R. Miller.

"Methods for Studying the Pharmacology of the Circulation," by C. Brooks.

"The Contour of the Intraventricular and the Pulmonary Arterial Pressure Curves by two new Optically Recording Manometers," by C. J. Wiggers.

"Some Time-saving Laboratory Methods," by C. C. Guthrie.

"A Graphic Method for Recording the Coagulation of Blood," by W. B. Cannon and W. L. Mendenhall.

"Some Mutual Relations of Oxalates, Salts of Magnesium and Calcium: Their Concurrent and Antagonistic Actions," by F. L. Gates and S. J. Meltzer.

"A Method of Obtaining Successive Contrast of the Sensations of Hunger and Appetite," by A. J. Carlson.

"Further Observations on the Pyramidal Tracts of the Raccoon and Porcupine," by S. Simpson.

"A New Apparatus for Demonstration of the Dioptrics of the Eye and the Principles of Ophthalmoscopy and Retinoscopy," by A. Woelfel.

"Simple Experiments on Respiration for the Use of Students," by Y. Henderson.

"Convenient Modification for Venous Pressure Determinations in Man," by R. D. Hooker.

"Device for Interrupting a Continuous Blast of Air. Designed Especially for Artificial Respiration," by R. A. Gesell and J. Erlanger.

"A Simple Liver Plethysmograph," by C. W. Edmonds.

"An Artificial Circulation Apparatus for Students," by W. P. Lombard.

"A Simplified and Inexpensive Oxydase Apparatus," by H. H. Bunzel.

"An Improved Form of Apparatus for Perfusion of the Excised Mammalian Heart," by M. Dresbach.

"Sugar Consumption in Eviscerated Animals," by J. J. R. Macleod and R. G. Pearce.

"On the Rapid Disappearance from the Blood of Large Quantities of Dextrose Injected Intravenously," by I. S. Kleiner and S. J. Meltzer.

"Further Observations on the Metabolism of Depancreatinized Dogs," by J. R. Murlin.

"Transfusion of Blood in Severe Diabetes Mellitus," by R. T. Woodyatt and B. O. Raulston.

"The Cause of Diabetic Polyphagia," by A. B. Luckhardt.

"Preliminary Report on Work with a Respiration Calorimeter in Bellevue Hospital," by E. F. DuBois.

"The Rôle of Nascent Oxygen in Protecting the Body from Self-digestion," by W. E. Burge.

"The Effect of Castration on the Hypophysis in the Rabbit," by A. E. Livingston.

"The Secretion of Gastric Juice during Parathyroid Tetany," by R. W. Keeton.

"The Brain-Adrenal-Thyroid-Liver-Pancreas Syndrome (Kinetic System)," by G. W. Crile.

"The Variations in the Hunger Contractions of the Empty Stomach with Age," by T. L. Patterson.

"The Control of the Hunger Mechanism," by A. J. Carlson.

The following persons were elected to membership in the society: E. F. DuBois, Cornell University Medical School; O. C. Glaser, University of Michigan; E. M. Ewing, Bellevue Medical School; S. Tashiro, University of Chicago; A. L. Tatum, University of Chicago; H. Laurens, Yale University; J. E. Sweet, University of Pennsylvania; E. Lodholz, University of Pennsylvania; G. Fahr, Johns Hopkins Medical School; J. H. King, Johns Hopkins Medical School; R. E. Gesell, Washington University, St. Louis; O. O. Stoland, University of South Dakota; E. L. Porter, Harvard Medical School; P. E. Howe, Columbia University; H. A. Mattill, University of Utah; Mabel P. FitzGerald, New York City.

This makes the total membership of the society 210.

The most important matter in the way of business was the ratification of the work of the conference committee appointed at the Cleveland meeting establishing the Federation of American Societies for Experimental Biology. One of the aims of this federation is the coordination of the scientific work of the annual meetings, a successful beginning of which was made this year. But a great deal of the credit for this successful beginning is due to the splendid facilities offered by the Philadelphia institutions, and the careful planning and hard work of the local committee.

The Washington University presented an invitation to meet in St. Louis next year. The society voted in favor of meeting in St. Louis, but the final decision is left with the executive committee of the federation.

The editorial committee (Drs. Porter, Carlson, Erlanger, Howell, Lee, Lusk, Macallum) was instructed by the society to report at the next annual meeting on the relation of the *American Journal of Physiology* to the American Physiological Society and to propose measures to improve the facilities for publication on the part of American physiologists.

Officers for the year 1914.—President, W. B. Cannon; *Secretary*, A. J. Carlson; *Treasurer*, J. Erlanger; *Members of the Council*, F. S. Lee, S. J. Meltzer.

A. J. CARLSON,
Secretary

UNIVERSITY OF CHICAGO,
January 10, 1914

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE society met in affiliation with the American Association for the Advancement of Science in the state capitol at Atlanta, Ga., December 30, 1913, to January 2, 1914.

The following officers were elected:

President, Dr. Haven Metcalf, U. S. Department of Agriculture, Washington, D. C.

Vice-president, Dr. Frank D. Kern, Pennsylvania State Agricultural Experiment Station, State College, Pa.

Member of Council, Dr. H. R. Fulton, North Carolina Agricultural Experiment Station, West Raleigh, N. C.

Chief editors of *Phytopathology* were elected as follows: Dr. L. R. Jones, for one year; Dr. C. L.

Shear, for two years; Dr. R. A. Harper, for three years.

The following associate editors were elected for three years: Dr. F. D. Heald, Dr. Mel T. Cook, Dr. B. M. Duggar, Professor F. C. Stewart.

Dr. Donald Reddick was reelected business manager of *Phytopathology*.

About fifty members were in attendance.

The society decided to hold its next meeting in conjunction with the American Association for the Advancement of Science at Philadelphia, Pa.

The following program was presented by abstract, the abstracts having been published and distributed before the meeting. This plan was undertaken in an attempt to devise some means of securing time to discuss the numerous papers which are offered for presentation. These abstracts were read by the authors and formed the basis of questions and discussions. The plan was generally pronounced a great success, as it resulted in rather a full discussion of almost every paper presented.

"Fruit Rots of Egg Plant," by Frederick A. Wolf.

"Formaldehyde Gas Injury to Potato Tubers," by F. C. Stewart and W. O. Gloyer.

"Stem Rot and Leaf Spot of *Clematis*," by W. O. Gloyer.

"A Preliminary Note on the Cause of 'Pecky' Cypress," by W. H. Long.

"Inspection and Certification of Potato Seed Stock," by W. A. Orton.

"The Fungus Genus *Verticillium* in Its Relation to Plant Diseases," by W. A. Orton.

"A Phoma Rot of Irish Potatoes," by I. E. Melhus.

"A New Rust of Economic Importance Occurring on Pomaceous Hosts," by H. S. Jackson.

"Notes on the White Pine Blister Rust," by Perley Spaulding.

"Relation of the Mosaic of the Pepper and the Filiform Leaf of the Tomato to the Mosaic of the Tobacco," by Carl A. Schwarze.

"*Cladosporium* Disease of *Ampelopsis tricuspidatum*," by Mel. T. Cook and Guy West Wilson.

"The Use of Sulphur Lime Wash as a Remedy for Apple Scab," by R. Kent Beattie.

"Cotton Anthracnose. Some Field Problems and Some Field Experiments," by H. R. Fulton, J. R. Winston and R. O. Cromwell.

"Can *Cronartium ribicola* Overwinter on the Currant," by F. C. Stewart and W. H. Rankin.

"An Improved Method of Making Separation Cultures," by A. F. Blakeslee.

"Collar-blight of Apple Trees in Pennsylvania," by C. R. Orton and J. F. Adams.

"Fusaria of Potatoes," by C. D. Sherbakoff.

"Some Points in the Life History of *Phytophthora* on Ginseng," by J. Rosenbaum.

"Comparative Dusting and Spraying Experiments," by F. M. Blodgett.

"*Sphæropsis* Canker of *Quercus prinus*," by W. H. Rankin.

"Biological Strains of *Sphæropsis malorum*," by L. R. Hesler.

"Decay of Celery in Storage," by D. Reddick.

"A Destructive Nematode Introduced into the United States," by L. P. Byars.

"Experiments on the Control of Certain Barley Diseases," by A. G. Johnson.

"Some Observations and Experiments on the Black-leg of Cabbage," by M. P. Henderson. (With lantern.)

"The Non-validity of the Genus *Lasiodiplodia*," by J. J. Taubenhaus.

"Progress in Developing Disease Resistant Cabbage," by L. R. Jones. (With lantern.)

"Disease Resistance in Tobacco to Root Rot," by James Johnson. (With lantern.)

"The Life History of *Sphæropsis malorum* Berk.," by C. L. Shear. (With lantern.)

"Blossom-end Rot of Tomato," by Charles Brooks. (With lantern.)

"A Little-known Disease of Chestnut and Oak Trees," by F. D. Heald. (With lantern.)

"A Preliminary Report on Fruit Infection of the Peach by Means of Inoculation with *Cladosporium carpophilum* Thum. from Peach Twigs," by G. W. Keitt. (With lantern.)

"Bibliographical Citations," by C. L. Shear.

"Some Recent Studies on New or Little-known Diseases of the Sweet Potato," by J. J. Taubenhaus. (With lantern.)

"Wind Dissemination of Ascospores of the Chestnut Blight Fungus," by F. D. Heald, M. W. Gardner and R. A. Studhalter. (With lantern.)

"Longevity of Pycnospores of the Chestnut Blight Fungus in Soil," by M. W. Gardner.

"The Relation of Temperature to the Expulsion of Ascospores of *Endothia parasitica*," by R. C. Walton.

"Insects as Carriers of the Chestnut Blight Fungus," by R. A. Studhalter.

"Perithecia in Cultures of *Venturia inequalis*," by Fred R. Jones.

"Gum Formation in *Citrus* as Induced by Chemicals," by B. F. Floyd.

"A Study of the Annual Recurrence of *Phytophthora infestans*," by I. E. Melhus.

"Fungous Gummosis of *Citrus* in California," by H. S. Fawcett.

C. L. SHEAR,
Secretary-Treasurer

THE PALEONTOLOGICAL SOCIETY

THE fifth annual meeting of the Paleontological Society was held at Princeton, N. J., on Wednesday, December 31, 1913, and Thursday, January 1, 1914, in affiliation with the Geological Society of America. The meeting this year included a general session in which selected papers of interest to all members of the society were read, and special sessions dealing with vertebrate and invertebrate paleontology and paleobotany. Notable features of the meeting were first, the president's address by Dr. Charles D. Walcott on the Cambrian of western North America, and second a conference on the close of the Cretaceous and opening of Eocene time. In the latter the geological and paleontological evidence was presented by Messrs. F. H. Knowlton and T. W. Stanton, and recent discoveries in regard to late Cretaceous and early Eocene life were reported especially as a result of the American Museum expeditions under Messrs. Barnum Brown and Walter Granger.

A new Ungulate of very distinctive South American type was recorded by Dr. Matthew as additional evidence of affinity between North and South America in Lower Eocene times. The line of ancestry of the uintatheres was recorded as traced into Basal or Paleocene times. A new fauna is described between the Puerco-Torrejon and Wasatch, to be known as the Clark Fork. Still more striking was the record of Mr. J. W. Gidley, of the U. S. National Museum, of the occurrence of a true eland *Taurotragus* in the Pleistocene cave of western Maryland. This discovery confirms the statement of J. C. Merriam of the occurrence of African antelopes in Virgin Valley, northern Nevada and links North America very closely to Asia in Pliocene times. Accompanying the eland was a peculiar species of African dog.

R. S. BASSLER,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 516th meeting of the society was held on November 15, 1913, Vice-president Paul Bartsch in the chair and 35 persons present.

F. V. Coville presented a communication on "The Physiology of the Blueberry." His remarks were based on wide experience in greenhouse and outdoor culture of this plant. Three conditions are essential to its successful propagation: first, an acid soil; second, the presence of the micorrhizal fungus to enable the plant to obtain nitrogen, and third, the stimulating effect of cold on the twigs while they are dormant. The last is a condition of vital importance, associated as it is with the transformation of starch into sugar. As a result of this series of experiments, the commercial propagation of the blueberry is now possible. Very large berries have been developed, some of them from ½ inch to ¾ inch in diameter. The various means of cultivation were explained and illustrated by means of numerous lantern slides.

W. C. Kendall, the second speaker announced on the program, was absent, and the chairman asked Dr. Leon J. Cole, of the University of Wisconsin, to address the society. He responded by giving an account of his experiments in breeding pigeons for the study of color inheritance.

Owing to lateness, the communication by Barton W. Evermann was postponed.

THE 517th meeting of the society was held on November 29, 1913, President E. W. Nelson in the chair and 63 persons present.

The meeting was devoted to a discussion of Parallel Development. A. D. Hopkins read a paper on "Parallelism in Morphological Characters and Physiological Characteristics in Scolytoid Beetles." He had made a special study of these beetles and his ideas of parallelism in nature were largely founded on evidence they have furnished. He defined the subject as follows:

"Parallelism in morphological characters and physiological characteristics in Scolytoid beetles relates to the occurrence of the same or similar elements of structure or the same kind of activity in two or more species, genera, subfamilies or families. Parallel species, genera and larger groups are those in which structure or habit is in many respects alike. Such species or groups may be closely allied or more or less widely separated. Universal parallelism relates to repeated or multiple origin, development and evolution of the same or similar inorganic or organic form or activity.

"This tendency towards parallel development appears to be in accordance with a fundamental principle or law of *parallelism in evolution*, under which the origin and evolution of the same form or activity, under the same or similar physical in-

fluences, has been repeated many times; or, in other words, that under similar environments, needs, and requirements in nature, independent development and evolution from a common base may produce repeatedly the same or similar morphological and physiological results."

Numerous examples were given and illustrated on the board, of characters of structures and characteristics of habit which were paralleled over and over again in connected and disconnected genera, subfamilies and families. He also illustrated characters and characteristics which were paralleled in all of the species of a single genus and in connected genera, groups, subfamilies and families, and said further:

"Thus we see that parallel modification in morphological and physiological elements is an important factor to be considered in taxonomy. It is evident from a comparative study of the various systems of classification that the failure of taxonomists to fully realize its importance has led to many erroneous conclusions and much confusion.

"In conclusion, it seems to me that we have two fundamental questions to be answered in regard to the origin, evolution and classification of organism:

"1. Are the taxonomic characters and characteristics of the species, genus, family, order, class and kingdom, *the result of phylogenetic descent from a single ancestral nucleus, through natural selection and the inheritance of selected characters?* or

"2. Are they *the result of phylogenetic descent from many nuclei through natural selection and natural parallelism?*

"I am inclined to the belief that an affirmative answer to the second question would be more nearly in accordance with natural law.

"Phylogenetic descent from a single source is represented by a single genealogical tree.

"Parallelism from different sources may be represented by a forest of genealogical trees, the different elements of which are as near alike as the branches, leaves, flowers and fruit of a forest of oak trees."

President Nelson exhibited a series of mammals similar in outward appearance but widely different in structure and classification, showing the parallelism of shape and color.

H. C. Oberholser discussed parallel development as illustrated in birds. He showed a large series of specimens in which resemblances in form and color were very striking.

J. W. Gidley pointed out the difference between parallel and convergent development.

Messrs. Lyon, Hay, Baker, Bartsch and Gill took further part in the discussion.

In closing, Dr. Hopkins remarked on the large number and most striking examples of parallelism in the mammals and birds which had been exhibited by Messrs. Nelson and Oberholser, stating that the discussion based on them had related to only one phase of the principle, namely, disconnected or homomorphic parallelism which was very different from related or homologous parallelism. One is parallelism in structure, color, habit, etc., which is not correlated with evidences of natural affinity, but is repeated in more or less widely separated groups and species, while the other is parallelism of structure, color, habit, etc., which is correlated with evidences of natural affinity and is repeated in the same species or in connected genera or larger groups.

We must not overlook the fact that there are many different kinds of parallel modifications in evolution, some applying to the universe in the parallel development of systems, suns and planets, others to chemical elements and compounds, others to psychological phenomena, etc. Indeed, its manifestation in all branches of human knowledge is so evident that it may be considered as representing a science.

The 34th annual meeting and 518th regular meeting of the society was held on December 13, 1913, President E. W. Nelson in the chair and 28 persons present.

The annual reports of the officers were read.

The election of officers for the year 1914 resulted as follows:

President: Paul Bartsch.

Vice-presidents: J. N. Rose, A. D. Hopkins, W. P. Hay, Mary J. Rathbun.

Recording Secretary: D. E. Lantz.

Corresponding Secretary: W. L. McAtee.

Treasurer: Wells W. Cooke.

Members of Council: William Palmer, Hugh M. Smith, Vernon Bailey, Marcus W. Lyon, Jr., N. Hollister.

The president, Paul Bartsch, was selected to represent the society as vice-president in the Washington Academy of Sciences.

President Bartsch appointed the following committee on publication: N. Hollister, W. L. McAtee, Wells W. Cooke.

D. E. Lantz,
Recording Secretary

SCIENCE

FRIDAY, FEBRUARY 6, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH[1]

II. THE FIRST HALF CENTURY OF THE NATIONAL ACADEMY OF SCIENCES

IN the days preceding the American Revolution, the Royal Society was to this country what it still is to the existing British Colonies: the central and authoritative representative of scientific research.[2] Americans eminent for their contributions to science were elected Fellows, and their papers appeared in the *Philosophical Transactions.* The list of colonial Fellows includes Cotton Mather, Bowdoin, Dudley, and the three Winthrops in New England; Franklin, Rittenhouse and Morgan in Pennsylvania; Banister, Clayton, Mitchell and Bird, in Virginia, and Garden and Williamson in the Carolinas. But so distant a body could not meet all local needs. Thus Franklin, active in every field, undertook the organization of the American Philosophical Society in 1743, some years before its time, as its early demise proved. In 1766 the American Society held at Philadelphia for Promoting Useful Knowledge was established and Franklin, then in Europe, was elected its first president. In the meantime the earlier society was revived, and

[1] For most of the material in the following pages the writer is indebted to a history of the "First Half Century of the National Academy of Sciences," prepared and edited by Frederick W. True in connection with the recent celebration of the fiftieth anniversary of the founding of the academy.

[2] See an excellent article by G. Browne Goode, from which the data used in the introduction of the present paper are taken: "The Origin of the National Scientific and Educational Institutions of the United States," Annual Report of the American Historical Association for 1889.

the amalgamation of the two in 1769 gave rise to a scientific body which has always exercised a powerful and beneficent influence on the progress of science in the United States. The prominence in the affairs of state of its leading members is illustrated in the frequent interruptions to the proceedings of the society between 1773 and 1779, when these men, who included Washington, Franklin, Jefferson and Adams, were occupied with the labors of organizing the new republic. The American Philosophical Society, modelled after the Royal Society, but embracing the whole field of knowledge, soon assumed great importance at its seat in Philadelphia, then the center of American scientific and literary life.

John Adams, when representing the United States in France, learned of the appreciation in which the Philosophical Society was held in academic circles. On his return to Boston in 1779 he suggested the establishment of the American Academy of Arts and Sciences, which was duly incorporated by act of the Massachusetts State Legislature in 1780. At this time the influence of France was naturally more potent than that of England, and the Academies of Paris were chosen as models by the charter members of the new organization.

The year 1778 marks the inception of an ambitious plan, proposed by the Chevalier Quesnay de Beaurepaire. His scheme for the Academy of Arts and Sciences of the United States had been endorsed by the King of France, the Royal Academies of Science and of the Fine Arts, and by Lavoisier, Condorcet and many eminent Frenchmen. The sum of sixty thousand francs was subscribed by wealthy Virginians, and a building was erected in Richmond in 1786. One (French) professor was appointed to make natural history collections and extensive plans for branch establishments in Baltimore, Philadelphia and New York were contemplated. But the French Revolution put an end to this intellectual exotic.

In the present paper, devoted primarily to the history of the National Academy, we must pass over many interesting developments in the early scientific life of the nation, some of which will be mentioned elsewhere. Reference must be made, however, to the incorporation of the American Association for the Advancement of Science in 1848, and the intense vitality which has enabled this body, in cooperation with many special societies of later origin, to bring the results of scientific research within the reach of an ever-widening public.

Alexander Dallas Bache, superintendent of the United States Coast Survey from 1843 to 1867, and one of the leading spirits of his time, was among the first to express publicly the demand for a national organization of American research officially recognized as such by Congress. In his presidential address to the American Association for the Advancement of Science in 1851 he emphasized the need of "an institution of science, supplementary to existing ones, to guide public action in reference to scientific matters."

Suppose an institute of which the members belong in turn to each of our widely scattered states, working at their places of residence and reporting their results; meeting only at particular times, and for special purposes; engaged in researches self-directed, or desired by the body, called for by congress or by the executive, who furnish the means for the inquiries. . . . The public treasury would be saved many times the support of such a council, by the sound advice which it would give in regard to various projects which are constantly forced upon their notice, and in regard to which they are compelled to decide without the knowledge which alone can ensure a wise conclusion.

. . . Such a body would supply a place not occupied by existing institutions, and which our own

is, from its temporary and voluntary character, not able to supply.[3]

As president of the American Association, and as a prominent member of the American Philosophical Society and the American Academy of Arts and Sciences, he entertained no misconception regarding the admirable aims and the no less admirable successes of these older societies. Each performed then, as it does now, a useful function of broad scope, which the proposed organization was not to rival but to supplement. The American Philosophical Society continues to exert a wide and useful influence, drawing to its annual meetings in Philadelphia a large body of able men, representing every field of knowledge. Its strong vitality and its traditions of a scholarly past are shared by the American Academy, now rapidly increasing in membership and advantageously established in the permanent home provided for it in Boston by Alexander Agassiz. The American Association, like the British Association for the Advancement of Science, holds its annual meetings in widely scattered cities, thus bringing under its influence a great number of people, whose attention might not be attracted from a distance. Clearly there was still room for an academy chartered by congress and closely related to the national government, to which it might render some such services as the principal countries of Europe receive from their great academies.

Bache's hopes were to be realized twelve years later. On February 11, 1863, Gideon Welles, secretary of the navy, appointed Admiral Davis, Professor Henry and Professor Bache a "Permanent Commission" "to which shall be referred questions of science and art upon which the (navy) department may require information."[4] Encouraged by this governmental recognition, Bache, Peirce, Davis, Gould and Agassiz induced Senator Wilson, of Massachusetts, to introduce in congress a bill to incorporate the National Academy of Sciences. This passed the Senate and House on March 3, 1863, and was signed by the president on the same day.

The act of incorporation named fifty men of science as charter members, and limited the membership of the Academy to this number. A second act of congress, passed in 1870, removed this limitation. At present the amended constitution provides that ten new members may be elected annually, and fixes the limiting membership at one hundred and fifty. The actual number of names now on the roll is one hundred and thirty-two. In addition to these there are forty-nine foreign associates and one honorary member.

The list of incorporators contains many distinguished names: Agassiz, Alexander, Bache, Barnard, Dana, Davis, Gilliss, Gould, Wolcott Gibbs, Asa Gray, Guyot, James Hall, Henry Hilgard, Le Conte, Leidy, Lesley, Newberry, Newton, Peirce, Rogers, Rutherfurd, Silliman, Torrey, Whitney, Wyman—among others equally well known. Chosen from the country at large, and fairly representative of the science of the day, the membership was worthy of a truly national body.

The organization of the National Academy was "the first recognition by our government of the importance of abstract science as an essential element of mental and material progress."[5] One of the objects in the minds of its founders was to confer distinction on men of science who had accomplished important original research, and thus to encourage and stimulate them

[3] *Op. cit.*, pp. 7, 8.

[4] *Op. cit.*, p. 1.

[5] From the report for 1867 of Joseph Henry, president of the National Academy, *op. cit.*, p. 14.

to further effort. Another prime object was to aid the government in the solution of problems of a scientific nature. In 1863, the year of the Academy's incorporation, the civil war was in progress, and the government stood in need of just such advice as a body of able scientific men could supply. It will be seen later that the assistance of the Academy was often sought and rendered, not alone in this period, but also in subsequent years.

The idea that a democratic government could not consistently confer distinction upon its citizens, though held by some critics of the day, was not shared by Joseph Henry, whose words may again be quoted from the report cited above:

It is not enough for our government to offer encouragement to the direct promotion of the useful arts through the more or less fortunate efforts of inventors; it is absolutely necessary, if we would advance or even preserve our reputation for true intelligence, that encouragement and facilities should be afforded for devotion to original research in the various branches of human knowledge. In the other countries scientific discovery is stimulated by pensions, by titles of honor and by various social and official distinctions. The French academicians receive an annual salary and are decorated with the insignia of the Legion of Honor. Similar marks of distinction are conferred on the members of the Academy of Berlin and that of St. Petersburg. These modes of stimulation or encouragement may be considered inconsistent with our social ideas and perhaps with our forms of government. There are honors, nevertheless, which in an intelligent democracy have been and may be justly awarded to those who enlarge the field of human thought and human power. Heretofore, but two principal means of distinction have been recognized in this country, viz.: the acquisition of wealth and the possession of political power. The war seems to have offered a third, in bestowing position and renown for successful military achievement. The establishment of this Academy may be perhaps regarded as having opened a fourth avenue for the aspirations of a laudable ambition, which interferes neither with our national prejudices nor our political principles, and which only requires the fostering care of government to become of essential benefit and importance not only to this, but all the civilized countries of the world.[6]

The special problems raised by the civil war emphasized the value of the services which the Academy might render the government, at a period when most of the scientific bureaus of later years were not yet organized. But the war had only an incidental bearing on the designation of the Academy as the scientific adviser of the nation. The desire of President Lincoln and his Secretary of State to receive advice from the Academy on more general questions is shown by the following letter from Secretary Seward to President Bache:[7]

DEPARTMENT OF STATE,
WASHINGTON, January 8, 1864.

Sir: I have the honor to acknowledge the receipt of your note of the 7th instant, tendering to this department the aid of the Academy of Sciences in any investigation that it may be thought proper to institute with a view to the great reform of producing an uniformity of weights and measures among commercial nations. Be pleased to express to the Academy my sincere thanks for this enlightened and patriotic proceeding, and assure them that, with the authority of the President, I shall be happy to avail myself of the assistance thus tendered to me, and to that end I shall at all times be happy to receive the suggestions of the Academy, or of any committee that may be named by it, in conformity with the spirit of the note you have addressed to me.

I am, Sir, your obedient servant,
WILLIAM H. SEWARD.

We shall have occasion later to consider how the Academy has assisted the government in the solution of problems of the most diverse character.

The first meeting of the National Academy, attended by more than three fifths of the incorporators, was held at the University of the City of New York on April 22, 1863. Senator Wilson, who had introduced in the senate the bill of incorporation, ad-

[6] *Op. cit.*, p. 14.

[7] *Op. cit.*, p. 16.

dressed the Academy at the opening of the first session. After alluding to the fact that the idea of forming such an institution had long existed, he dwelt on the significance of unanimous action by congress at a time when the country was suffering under the burden of the great civil war. With its widely distributed membership, he felt that the Academy would contribute in the future toward the unity and indivisibility of the nation.

With Professor Henry in the chair, and other leaders of American science taking part in the deliberations, the work of the Academy was begun under the most favorable auspices. The constitution and bylaws were prepared by a strong committee, including such men as Agassiz, Benjamin Gould, Peirce and Silliman, with Bache as chairman. After three days of discussion they were adopted by the Academy, and finally ratified at the first Washington meeting, held in one of the committee rooms of the senate on January 4–6, 1864.

In the space at our disposal, we must content ourselves with a brief glance at the principal acts of the Academy during the fifty years of its existence, referring the reader to the work so often cited for further details. In accordance with the terms of the constitution, the members were divided into two classes, (*a*) mathematics and physics, and (*b*) natural history, each class having a chairman and secretary. The names of the sections, and the number of members in each, are given in the following table:

Class of Mathematics and Physics

		Number of Members	
Sect. 1.	Mathematics	6	
Sect. 2.	Physics	6	
Sect. 3.	Astronomy, Geography and Geodesy	9	
Sect. 4.	Mechanics	6	
Sect. 5.	Chemistry	3	30

Class of Natural History

		Number of Members	
Sect. 1.	Mineralogy and Geology	6	
Sect. 2.	Zoology	5	
Sect. 3.	Botany	1	
Sect. 4.	Anatomy and Physiology	2	
Sect. 5.	Ethnology	0	14
	Total		44

It is interesting to contrast this organization with that existing at the present time:

Sect. 1.	Mathematics and Astronomy	23	
Sect. 2.	Physics and Engineering	25	
Sect. 3.	Chemistry	23	
		71	
	Deduct names counted twice.	5	66
Sect. 4.	Geology and Paleontology	24	
Sect. 5.	Botany	9	
Sect. 6.	Zoology and Animal Morphology.	18	
Sect. 7.	Physiology and Pathology	15	
Sect. 8.	Anthropology and Psychology	9	
		75	
	Deduct names counted twice	9	66
	Total		132

At the outset, two thirds of the members belonged to the class of mathematics and physics, and only one third to the class of natural history. At present, while the two classes no longer exist as such, it is easy to group the members in the same way. Deducting the names counted twice, we find that 66 would now fall in the first class, and exactly the same number in the second. Thus the discrepancy formerly existing between the two classes has been adjusted in the process of time.[8]

It is important to note that the division of members into sections is solely for the purpose of facilitating nominations for new elections, as now provided by the constitution.

[8] DeCandolle notes a similar preference for the mathematical and physical sciences on the part of the Berlin Academy during the eighteenth century, which was subsequently adjusted by revision of the statutes. ("Histoire des Sciences et des Savants," 2 ed., p. 261.)

In view of the preponderance of physicists, it is not surprising that three fourths of the scientific papers read at the first Washington meeting were connected with the physical sciences. These papers were referred to the committee on publication, with instructions to publish, but the lack of funds for this purpose stood in the way. When the first volume of the *Memoirs* finally appeared in 1866, it contained but two of these papers. It was then planned to print the minor papers in the *Proceedings* of the academy, but this was never done. The first part of the first volume of the *Proceedings* was published in 1877. This contained the constitution and by-laws, reports on the principal business actions of the Academy, and much miscellaneous matter relating to resolutions passed, titles of papers presented, reports of committees, etc. Publication of the *Proceedings* was discontinued in 1895, after three parts had appeared.[9] In 1881, 649 papers had been read at the scientific sessions. President Rogers, feeling that the Academy would have received much more recognition from the scientific world if these had been printed, strongly and repeatedly urged that the papers be collected annually and transmitted to congress with the report.[10] Unfortunately this was never done, and the reports still give only an abstract of the proceedings, in which the papers appear by title. The importance of reviving and enlarging the *Proceedings* will be discussed in another article.

The Academy has published eleven volumes of *Memoirs,* containing 68 quarto papers, and seven volumes of *Biographical Memoirs* of deceased members, in addition to annual reports and reports of committees.

In view of the existence of a detailed history of the Academy, it is quite unnecessary in the present paper to dwell at length upon the events of the first fifty years. A brief outline of the more important work of the Academy is nevertheless essential to clearness, especially in connection with the suggestions for the future which are to be presented later. We may, therefore, consider briefly: (1) the work of the members; (2) the Academy's work for the national government; (3) medals and trust funds, and (4) cooperation in research.

THE WORK OF THE MEMBERS

In his report for 1867 as president of the Academy, Joseph Henry spoke as follows of the conditions of membership:

> It was implied in the organization of such a body that it should be exclusively composed of men distinguished for original research, and that to be chosen one of its members would be considered a high honor, and consequently a stimulus to scientific labor, and that no one would be elected into it who had not earned the distinction by actual discoveries enlarging the field of human knowledge. . . . since the original organization, the principle before mentioned has been strictly observed, and no one has been admitted except after a full discussion of his claims and a satisfactory answer to the question, "What has he done to advance science in the line of research which he has especially prosecuted?"

And again, in his valedictory address to the Academy (1878), Henry returned to this subject.

> For this purpose great care must be exercised in the selection of its members. It must not be forgotten for a moment that the basis of selection is actual scientific labor in the way of original research; that is, in making positive additions to the sum of human knowledge, connected with unimpeachable moral character.
>
> It is not social position, popularity, extended authorship or success as an instructor in science, which entitles to membership, but actual new discoveries, nor are these sufficient if the reputation of the candidate is in the slightest degree tainted with injustice or want of truth.

[9] *Op. cit.*, p. 44.

[10] *Op. cit.*, p. 51.

These principles have been observed to the present day, sometimes in the face of great temptation to elect men eminent for achievements other than those of original research. Thus the Academy has counted among its members the large majority of the leaders of American science. While it is of course impossible to describe their individual contributions in these pages,[11] some remarks on the progress of American research since the foundation of the Academy will be given in a later paper.

THE WORK OF THE ACADEMY FOR THE NATION

In the first annual report of the president of the Academy, presented to congress in 1864, Professor Bache remarked:

> The want of an institution by which the scientific strength of the country may be brought, from time to time, to the aid of the government in guiding action by the knowledge of scientific principles and experiments, has long been felt by the patriotic scientific men of the United States. No government of Europe has been willing to dispense with a body, under some name, capable of rendering such aid to the government, and in turn of illustrating the country by scientific discovery and by literary culture.

In a previous paper the distinctive position held by European academies as organizations of the government, and the services they render to the state, have been briefly described.[12] Here, as elsewhere in these papers, we must not overlook the special conditions which distinguish the National Academy from similar bodies abroad. The Royal Society and the Paris Academy of Sciences, dating from the earliest beginnings of science in England and France, have been the media through which the great advances of more than two centuries have reached the world. Discovery after discovery, first presented at their meetings and published in their proceedings, has been rigidly associated in the public mind with these great societies, which have fostered science and encouraged the labors of investigators. Thus they have acquired a prestige and a power in the state which could arise in no other way. It is not enough for a nation to charter an organization and to authorize it to act as the adviser of the government in scientific affairs. Appreciation of the fundamental importance of science as the source of all industrial progress, and confidence in the body appointed to advise the nation, are obvious prerequisites to that cooperation between statesmen and men of science which is essential to complete success.

In spite of the disadvantage of a widely scattered membership, whose discoveries and contributions to science have always reached the world through other channels, and with no home of its own to focus attention on its activities, the National Academy has often been called into the service of the country. It will be sufficient to give here a list of the subjects on which the Academy has been consulted by the government, referring the reader to the "History of the National Academy" (pp. 201 to 331) for all details.

COMMITTEES APPOINTED BY THE ACADEMY ON BEHALF OF THE GOVERNMENT

1. Committees appointed in accordance with Acts of Congress.
   - 1871. On the Transit of Venus.
   - 1872. On Preparing Instructions for the *Polaris* Expedition.
   - 1878. On a Plan for Surveying and Mapping the Territories of the United States.
   - 1879. On a National Board of Health.
   - 1894. To Prescribe and Publish Specifications for the Practical Application of the Definitions of the Ampere and Volt.

[11] Biographies of the incorporators may be found in the "History of the National Academy," so often cited.

[12] SCIENCE, November 14, 1913.

1908. On the Methods and Expenses of Conducting Scientific Work Under the Government.

2. Committees appointed at the request of Joint Commissions and Committees of Congress.
   1884. On the Signal Service of the Army, the Geological Survey, the Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department.
   1902. On the Establishment of a National Forest Reserve in the Southern Appalachians.
3. Committees appointed at the request of the President of the United States.
   1870. On the Protection of Coal Mines from Explosion by Means of Electricity.
   1902. On Scientific Explorations in the Philippines.
4. Committees appointed at the request of the Treasury Department.
   1863. On the National Currency (Confidential).
   1863. On Weights, Measures and Coinage.
   1863. On Saxton's Alcoholometer.
   1864. On Materials for the Manufacture of Cent Coins.
   1866. On the Prevention of Counterfeiting.
   1866. On Spirit Meters.
   1866. On Proving and Gauging Distilled Spirits and Preventing Fraud.
   1866. On Metric Standards for the States.
   1870. On the Effect of Chemicals on Internal Revenue Stamps.
   1873. On an International Bureau of Weights and Measures.
   1875. On Water-proofing the Fractional Currency.
   1875. On Means of distinguishing Calf's Hair from Woolen Goods (Confidential).
   1876. On Artificial Coloring of Sugars to Simulate a Lower Grade According to the Standard on which Duties are Levied (Confidential).
   1876. On the Use of Polarized Light to Determine the Values of Sugars.
   1877. On Demerara Sugars.
   1878. On Building Stone to be used for the Custom House at Chicago (no report).
   1882. On the Separation of Methyl Alcohol or Wood Spirits from Ethyl Alcohol.
   1882. On Glucose.
   1882. On Triangulation Connecting the Atlantic and Pacific Coasts (no report).
   1884. On Philosophical and Scientific Apparatus.
   1885. On the Tariff Classification of Wools.
   1886
   and
   1887. On the Morphine Content of Opium.
   1887. On Quartz Plates used in Saccharimeters for Sugar Determinations.
   1890. To Formulate a Plan for a Systematic Search for the North Magnetic Pole.
5. Committees appointed at the request of the Navy Department.
   1863. On Protecting the Bottoms of Iron Vessels.
   1863. On Magnetic Deviation in Iron Ships.
   1863. On Wind and Current Charts and Sailing Directions.
   1864. On the Explosion on the United States Steamer *Chenango*.
   1864. On Experiments on the Expansion of Steam.
   1877. On Proposed Changes in the American Ephemeris.
   1881. On the Transit of Venus.
   1885. On the Astronomical Day, the Solar Eclipse of 1886, and the Erection of a New Naval Observatory.
6. Committees appointed at the request of the War Department.
   1864. On the Question of Tests for the Purity of Whiskey.
   1866. On the Preservation of Paint on Army Knapsacks.
   1867. On Galvanic Action from Association of Zinc and Iron.
   1873. On the Exploration of the Yellowstone.
   1881. On Questions of Meteorological Science and its Application.
7. Committees appointed at the request of the Department of State.
   1866. On the Improvement of Greytown Harbor, Nicaragua.
   1903. On the Restoration of the Declaration of Independence.
8. Committees appointed at the request of the Department of Agriculture.
   1870. On Silk Culture in the United States.
   1881. On Sorghum Sugar.
9. Committees appointed at the request of the Department of the Interior.
   1880. On the Restoration of the Declaration of Independence.

1896. On the Inauguration of a Rational Forest Policy for the Forested Lands of the United States.

It will be noticed that many of the questions referred to the Academy are of such a nature that, at the present day, they could be satisfactorily answered by one or another of the scientific departments of the government. This probably accounts for the fact that the requests for the Academy's assistance have become less numerous as the national laboratories and scientific bureaus have multiplied and improved. But after full allowance has been made for such wholly desirable developments, it remains true that questions of broad scope, requiring the cooperation of authorities in several fields of knowledge for their solution, must arise from time to time. In such cases the Academy can afford assistance obtainable in no other way, and an enlightened government will advantageously seek its counsel.

The overthrow of the spoils system in national politics will afford the Academy another opportunity to serve the nation. In France, when a professorship in the national university, or the directorship of a national observatory or laboratory falls vacant, the Academy of Sciences is requested to present its first and second choice of a successor. The Minister of Public Instruction then appoints one of the nominees to the position. In the United States the need of such counsel is no less urgent than in France.

MEDALS AND TRUST FUNDS

Election to the National Academy has always been appreciated as a high honor by American men of science. Fortunately, however, the recognition and assistance the Academy has been able to afford to investigators has not been confined to the gift of this mark of distinction. From time to time trust funds have been established, the incomes of which are devoted to the award of medals or to grants for research. The will of Alexander Dallas Bache, first president of the Academy, directed that the residue of his estate, after the death of his wife, should be paid over to the National Academy of Sciences for the "prosecution of researches in Physical and Natural Science by assisting experimentalists and observers." Bache's excellent example has often been followed, with the results shown in the following table:

Fund	Established	Original Capital	Present Capital	Purpose
Alexander Agassiz	1910	$50,000.00	$50,000.00	General use of the academy.
A. D. Bache	1879	47,500.00	56,000.00	Researches in physical and natural science.
Cyrus B. Comstock	1907	10,000.00	10,337.50	Prize every five years for investigations in electricity or magnetism or radiant energy.
Henry Draper	1885	6,000.00	10,000.00	Medal for investigations in astronomical physics. (Surplus for research.)
Wolcott Gibbs	1893	2,673.17	3,000.00	Aid of chemical science.
Benjamin Apthorp Gould	1897	20,000.00	20,000.00	Researches in astronomy.
O. C. Marsh	1912	9,377.65	9,377.65	Original research in the natural sciences.
John Murray	1911	6,000.00	6,000.00	To found Alexander Agassiz gold medal for original contributions in oceanography.
J. Lawrence Smith	1885	8,000.00	10,000.00	Lawrence Smith gold medal for original investigations of meteoric bodies. (Surplus for research.)
J. C. Watson	1883	18,666.82	25,000.00	Gold medal and money prize for astronomical investigations. (Surplus for research.)
Building Fund		7,000.00	7,000.00	

The importance of the part played by these funds in advancing science may be illustrated by reference to some of the results obtained.

The Agassiz Fund has proved to be of great value in meeting the general expenses of the Academy, for which there was formerly no provision except the dues of the members.

The Bache Fund made twelve appropriations to Hilgard for his magnetic survey of the United States, four to Langley for his important studies of the physical constitution of the sun, six to Wolcott Gibbs for his researches on complex inorganic acids and his studies of the action of chemical compounds upon the animal system, one each to Newcomb and Michelson for their classic determinations of the velocity of light, three others to Michelson for his equally fundamental optical researches, six to Rowland for his great work in mapping and identifying the lines of the solar spectrum, three to Pickering for his pioneer researches in stellar photography, two to Gould for his measurements of the Cordoba photographs of the southern heavens, six to Boss for his studies of solar and stellar motions and his precise measures of standard stars, and two to Osborn for the work of the Academy Committee on Correlation. These cases include only a fraction of the total number of grants from the fund.

The Barnard Gold Medal for Meritorious Services to Science, awarded every five years by Columbia University to the nominee of the National Academy, has been given to Rayleigh, Röntgen, Becquerel and Rutherford.

The first award of the Comstock Prize of fifteen hundred dollars was made last April to Professor Robert Millikan, of the University of Chicago, for his researches on the charge of the electron and related investigations.

The Henry Draper Gold Medal for astrophysical research has been awarded to Langley, Pickering, Rowland, Vogel, Keeler, Huggins, Hale, Campbell, Abbot and Deslandres. Several grants to assist investigation have also been made from the surplus income.

The capital of the Wolcott Gibbs Fund for chemical research is being increased by additions of accumulated income, and no grants are being made at present. The income of the Marsh Fund is also being added to the capital.

A large number of investigations have been assisted by the Gould Fund, including those of Doolittle, Parkhurst, Yendell, Newcomb, Leavenworth, Comstock and others. At present the income is used mainly for the support of the *Astronomical Journal*.

The Alexander Agassiz Gold Medal, established by Sir John Murray for oceanographic research, was awarded for the first time last April to Dr. Johan Hjort, of the Norwegian Fish Commission, for his valuable contributions to knowledge relating to deep-sea life.

The Lawrence Smith Gold Medal for the investigation of meteoric bodies has been awarded but once, to H. A. Newton, of Yale, for his researches on the orbits of meteors. Appropriations from the fund have supplied Yale University with apparatus for the photography of meteors, and provided for the publication of a catalogue of meteorites, for their chemical analysis and for the study of their luminous trains.

The Watson Fund has aided the important work of Chandler on the variation of latitude, and that of Comstock on the constant of aberration, in addition to many other important grants. Since 1901 the income has been very effectively used by Leuschner in the computation of the perturbations of the asteroids discovered by Watson. The Watson Gold Medal, with

one hundred dollars in gold, has been awarded to Gould, Schönfeld, Auwers, Chandler, Gill and Kapteyn for their astronomical investigations.

In view of its national charter, the high plane of its membership, and its special advantages as the representative of the United States in the International Association of Academies, the National Academy is most favorably qualified for the custody and efficient use of trust funds. Appreciation of this fact, amply indicated by the above list of gifts and bequests, should grow with the reputation of the Academy. It is safe to predict that the privilege of securing the Academy's aid in the control and disbursement of large sums for the benefit of science will be widely sought in the future. In this connection attention should be called to the present lack of medals and funds especially devoted to the recognition and aid of researches in mathematics, engineering, geology and various departments of biology and anthropology.

COOPERATION IN RESEARCH

As an agent for the furtherance of cooperative research, the National Academy occupies a unique position among American societies. In these days of far-reaching investigations, involving the common action of men of science distributed throughout the world, the great majority of cooperative projects are international in character. Here the peculiar advantage of the Academy appears. The International Association of Academies is made up of the national academies of sixteen countries. Each academy is pledged to support only such cooperative undertakings as are endorsed by the association. Thus the constituent members of this body, through their delegates at its triennial meetings, are most favorably placed for the initiation and furtherance of such international movements.

As an illustration of the work already undertaken by the National Academy in this field, mention may be made of the International Union for Cooperation in Solar Research. In 1904, the Academy, through its Committee on Solar Research, invited various academies, physical and astronomical societies, and other organizations interested in the subject, to send delegates to a conference, with a view to the initiation of international cooperation in this field. Meetings have since been held at Oxford in 1905, Paris in 1907, Mount Wilson in 1910 and Bonn in 1913. The constituent societies, each of which is represented in the Union by a standing committee, are as follows:

The Royal Society of London, the Academies of Amsterdam, Barcelona, Berlin, Paris, St. Petersburg, Stockholm and Vienna, the Swiss Society of Natural Sciences, the Astronomical Societies of London, America, France and Canada, the Physical Societies of Berlin, Italy, Spain, France and America, the Society of Italian Spectroscopists, the Solar Physics Committee, the Solar Sub-committee of the International Meteorological Committee and the National Academy of Sciences.

The standards of wave-lengths which are being established by the Union, as the result of extensive cooperative studies, will be used universally by spectroscopists. International committees, appointed by the Solar Union, are studying the solar rotation, the spectra of sun-spots and the intensity of the solar radiation, on a common plan. Spectroheliographs are also in use, for the almost continuous photography of the sun, at the observatories of Kodaikanal, India; Catania, Sicily; Potsdam, Germany; Meudon, France; Tortosa, Spain; Cambridge, England; Williams

Bay, Wisconsin; Tacubaya, Mexico; and Mount Wilson, California.

A new solar observatory, which is about to be established in New Zealand through the generosity of Mr. Thomas Cawthron, will fill the gap in longitude between California and India, and thus aid in keeping the rapidly changing phenomena of the solar atmosphere constantly under observation. At the Mount Wilson meeting of the Union, it was decided to enlarge its scope so as to include the whole range of astrophysics, and a representative committee was appointed to report on the classification of stellar spectra. It is now evident that the Solar Union is destined to play an increasingly important part in the field of international research.

The Solar Union is one of the organizations endorsed by the International Association of Academies, to which it makes regular reports. Another of the international investigations conducted under the auspices of the association is that of the Brain Commission, the American Committee of which is also closely related to the National Academy.

The Committee on International Paleontologic Correlation, appointed by the Academy in 1908, has recently completed its work. Aided by the Bache Fund, the committee has pushed forward the important work of correlating the geologic formations of Europe and America on the basis of their paleontologic contents. The results have been published in a series of papers, by members of the committee, most of which treat of the mammals of the tertiary epoch and the formations which contain them in North America. Marsh and Cope dealt with the formation of the American Eocene as units, even when their thickness ranged from 1,000 to 2,000 feet. These formational units have now been split up into sub-units, or life zones, usually distinguished by geologic discontinuity. At the same time there has been a marked increase in the precision of recording the succession of species in certain formations which contain several levels of life zones, thus permitting exact comparisons with other life zones to be instituted. The importance of such work is obvious in connection with the trend and rate of development in different parts of the world, the possibility of geographic intercourse at certain epochs, and the cycles of physiographic and climatic change.

It is thus evident that the Academy is in a most favorable position to extend its operations in the field of international research, where the advantages of its national and representative character are felt to the full, and the disadvantages of its scattered membership are of minor importance.

From this brief survey it appears that the National Academy of Sciences, in spite of many obstacles, has played an important part in the development of American science. The time is now favorable for an extension of its work into new fields, which must be occupied if the special opportunities and obligations implied by the Academy's national charter are to be fully realized. In a later article some of the possibilities of future progress will be considered.

George Ellery Hale

Mount Wilson Solar Observatory

THE PLAN OF WORK IN CONNECTION WITH A NEW MARINE LABORATORY ON THE PACIFIC

During the past summer a new marine station was erected at Laguna Beach, California. At this place the varied and rocky coast offers peculiar advantages for the study of plant and animal life. The situation, too, is convenient for those in southern California, being within fifty miles from Los Angeles and easily accessible from other cities and towns.

The wealth of life at Laguna has attracted students of Pomona College during the past three years to visit this region for summer work. The growing interest of students and others in sea-side studies led to the erection of an adequate building. This contains two general laboratories, dark room, store rooms, aquarium for living specimens and nine private laboratories with fresh and salt water. There is in addition to the main building a tank house with two more rooms. The laboratory is established chiefly for teaching purposes, but there are facilities for a limited number of investigators. The plan of investigation and to some extent the work of teaching is organized along a definite line.

The laboratory is but one station for zoological work. The other center is situated fifty-five miles inland at Pomona College, Claremont. Between the two stations there are ranges of hills, low mountains with small streams and lakes, and great level stretches. Back from Claremont and the college buildings the mountains of the San Gabriel range, often covered with snow, rise to an elevation of ten thousand feet, and beyond them stretches the desert with its lower ranges and arid valleys. In this area a careful survey is to be made of all groups of living things, not all at once, but bit by bit, not by a few, but by many.

Some of the advantages of the location and of the climate are such as to contribute to the success of the enterprise. Field work may be undertaken at all times during the year at Laguna and to a large extent about Claremont. One of the chief recreations of the students is in the form of long or short expeditions into the mountains, and their services are enlisted to obtain specimens from different regions of high and lower altitude. In this way many interesting things have already been brought to light. Some species, for instance, are found to have a very local distribution on some mountain slope or in the depths of some scarcely accessible canyon. Besides the collection of specimens, there are possibilities in the way of observation of large animals, such as mountain sheep, deer, mountain lions and many smaller mammals and birds.

One of the features of class exercises in introductory courses is the collection of entomological and other zoological specimens with full data, as well as field work of other kinds. By these means the student obtains knowledge of the different animal groups, and the rough materials for more careful investigations are collected. For the more advanced workers special groups or special problems are studied in the field or in the laboratory. The necessary determinations are made so far as possible by the students, but their material is sent to specialists for confirmation. The results of this survey are not to be confined to mere records of species, but so far as possible in every group an attempt will be made to determine the adaptations to the environment, the relation of the insects and other forms to the cultivated plants in the region. Records are to be kept of climatic conditions from season to season and from year to year. Specimens collected at various times are kept with date and locality label until special students or specialists can determine them. At no time will the work on a particular family, order or class be regarded as finished, but from month to month new records are to be added. Although systematic investigations may come first in point of time, the effort will be made to determine other things from the material as occasion arises. This will necessitate a broad study of plant forms, topographical and climatic factors, as well as the interrelations of the animals studied. Knowledge of life histories and habits will also be a natural feature of the work.

There is so much ground to cover in this great outline, that it will be years before much of an impression is made upon the unknown, and it may be a long time before certain isolated facts seem to have any value or bearing on the rest. It is the purpose before long to have a special fireproof room to keep the specimens and records for the use of present workers and for the future. These data ought to be very valuable in a few years to many special

investigators. Some of the results of the work appear from time to time in the *Journal of Entomology and Zoology*, which is published quarterly by the college.

There are of course great gaps in the whole plan. Only here and there can a little be done at a time, but it is believed that by encouraging classes and individuals to collect data and specimens, and, when well trained, to record observations of a more difficult nature, we have an opportunity to do a great work which is unique and can not help but benefit all who partake in the effort. Whatever may be the value of the facts obtained and tested, whatever the value of the discovery of new species or new adaptations, there is, I believe, the value of method for the beginning student or the more advanced one. It will not matter what study he pursues after leaving college for the university; an awakened interest in things out of doors, an increased accuracy of observation should result. It seems to me too that the thought of contributing something to science, no matter how small a fact, ought also to be a stimulus in the future as it has been in the past.

William A. Hilton

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WINSLOW UPTON

Winslow Upton, professor of astronomy and director of the Ladd observatory at Brown University, died of pneumonia, at Providence, on January 8, in the sixty-first year of his age. His forbears were of north England origin but early in the seventeenth century the founder of the New England family emigrated to Massachusetts. Professor Upton was born on October 12, 1853, and was the fourth son of James Upton, a prominent merchant of Salem, Mass., and a liberal contributor to Brown University. Entering Brown in 1871 he was graduated as valedictorian of the class of 1875. He had attained to almost equal excellence in the pursuit of studies in ancient classics and in science, but he felt that his forte was rather in the line of scientific investigation. So he turned to the University of Cincinnati for graduate work in astronomy and was there awarded the degree of A.M. in 1877. His alma mater conferred on him the honorary degree of Sc.D. in 1906.

He was assistant in the astronomical observatory at Harvard, 1877–79; assistant engineer in the U. S. Lake Survey at Detroit, 1879–80; computer in the U. S. naval observatory at Washington, 1880–81; computer and assistant professor in the U. S. Signal office, 1881–84.

In 1884 he was appointed professor of astronomy at Brown University and since 1891 he has been both professor of astronomy and director of the Ladd observatory (the gift of the late Governor H. W. Ladd) which was built under his supervision. The facilities of the observatory have been used chiefly to aid in the instruction of the university, in the maintenance of a local time service, and in regular meteorological observations in cooperation with the U. S. Weather Bureau.

Professor Upton has been connected with a number of important scientific parties. He was a member of the U. S. astronomical expeditions to observe the total eclipse at Denver, Colorado, in 1878, and at the Caroline Islands in the South Pacific, in 1883. He also observed the solar eclipse of 1887 in Russia, that of 1889 in California, of 1900 in North Carolina, and during a sabbatical year, 1896–97, he was attached to the southern station of the observatory of Harvard College, at Arequipa, Peru.

Professor Upton's publications, for the most part in the department of meteorology, include the following:

1. "The Solar Eclipse of 1878," a lecture before the Essex Institute (*Bulletin of the Essex Institute*, Vol. 11. 1879; reprinted, pp. 19).

2. "Photometric Observations Made Principally with the Equatorial Telescope of Fifteen Inches Aperture During the Years 1877–79"; by E. C. Pickering, C. Searle and W. Upton (*Harvard Astr. Obs. Ann.*, Vol. 11, 1879, pp. 317).

3. "Information Relative to the Construction and Maintenance of Time-balls" (Wash-

ington, 1881, pp. 31 + 3 pls., U. S. War Dept. Professional papers of the Signal office, No. 5).

4. "Lectures on Practical Astronomy," 1882 (Report of the Chief Signal Officer, Washington, 1882, pp. 104–120).

5. "On the Methods Adopted in the Computation of Barometric Reduction Constants" (Report of the Chief Signal Officer, Washington, 1882, appendix 61, pp. 826–846, Washington, 1883).

6. "The Use of the Spectroscope in Meteorological Observations" (U. S. signal service notes, No. IV., pp. 7 + 3 pls., Washington, 1883).

7. "Report of Observations Made on the Expedition to Caroline Islands to Observe the Total Eclipse of May 6, 1883" (reprinted from *Memoirs of the National Academy of Sciences*, Vol. 2, Washington, 1884, pp. 64 + 7 pls.).

8. "Distribution of Rainfall in New England February 10–14, 1886, from Observations reported to the New England Meteorological Society" (reprinted from SCIENCE of March 19, 1886, *Providence*, 1886, pp. 8).

9. "An Investigation of Cyclonic Phenomena in New England" (1887).

10. "Meteorological Observations During the Solar Eclipse August 19, 1887, at Chlamostina, Russia" (reprinted from the *American Meteorological Journal*, Ann Arbor, 1888, pp. 25).

11. "The Storm of March 11–14, 1888" (reprinted from *American Meteorological Journal*, May, 1888, pp. 19).

12. "Characteristics of New England Climate" (*Harvard Astr. Obs. Ann.*, Vol. 21, 1890, pp. 265–273).

13. "Meteorologial and Other Observations Made in Connection with the Total Solar Eclipse of January 1, 1889, at Willows, California," by W. Upton and A. L. Rotch (*Harvard Astr. Obs. Ann.*, Vol. 29, 1892, pp. 34 + 2 pls.).

14. "Star Atlas, Containing Stars Visible to the Naked Eye and Clusters, Nebulæ, and Double Stars Visible in Small Telescopes . . . and an Explanatory Text" (Boston, Ginn and Co., 1896, pp. iv + 34.

15. "Geographical Position of Arequipa Station" (*Harvard Astr. Obs. Ann.*, Vol. 48, 1903, pp. 52 + 1 pl.).

He was also the contributor of numerous short articles to the *Astronomische Nachrichten* since 1877, to *Zeitschrift für Meteorologie, Siderial Messenger, Popular Astronomy, Science, American Meteorological Journal, Astronomical Journal* and other scientific publications. For over twenty years he wrote monthly letters on astronomical topics for the *Providence Journal* and was editor of the astronomical part of the Providence Journal Almanac 1894–1910.

Professor Upton was a fellow of the American Association for the Advancement of Science, a member of the Deutsche Meteorologische Gesellschaft, of the Phi Beta Kappa, Sigma Xi Societies and of the Delta Upsilon fraternity. He married, in 1882, Miss Cornelia Augusta Babcock, of Lebanon Springs, N. Y., and their two daughters are graduates of Smith College.

At Brown University Professor Upton was secretary of the faculty 1884–91, Dean 1900–1901, one of the committee on organization of the movement to increase the university endowment 1910–11; and, for more than a score years, a member of important administrative committees. He was also an active church worker, endowed with rare simplicity, genuineness, and warmth of Christian faith, and, at different times, glee-club and choir leader, and organist. His musical talents (so often the possession of astronomers and mathematicians) were inherited from his father; the George P. Upton who has given us many a pleasing volume on musical topics is a distant relative.

Professor Upton was possessed of unusual scientific ability, coupled with brilliancy and rare clarity of thought and power of exposition of intricate subjects. Too much, it seemed to some, did the university demand of his time and strength to deal with administrative problems, when he might so easily have multiplied his contributions to science. That extensive projects in this direction were contemplated are indicated by manuscripts left behind. He had a good deal of personal

magnetism, a joyous appreciation of refined humor, and was constantly in demand as a lecturer. In the class-room he displayed exceptional power to arouse enthusiasm. He was tactful and of judicial temper, a man inspired with the highest ideals in the conduct of life and possessed of unfailing patience, of great tenderness of heart and kindliness of spirit. He was beloved alike by colleagues and students.

Only a week ago, our friend was in the classroom. Because of the tragic swiftness of his passing—for just the other day he seemed to us but in the prime of bodily and mental vigor—a pregnant hush of introspection pervades the academic community. This afternoon his body was borne to his native city.

"Warte nur, balde
Ruhest du auch."

R. C. Archibald

Brown University,
January 10, 1914

SCIENTIFIC NOTES AND NEWS

The fourth annual award of the Willard Gibbs Medal, founded by Mr. William A. Converse, will be made by the Chicago Section of the American Chemical Society to Dr. Ira Remsen, of Johns Hopkins University. The previous recipients of this medal are Professor Svante Arrhenius, Professor Theodore W. Richards and Dr. Leo H. Baekeland. The formal presentation will be made to Dr. Remsen at the May meeting of the Chicago Section of the American Chemical Society. Dr. Remsen has formally signified his acceptance of this award. The jury of award which selected Dr. Remsen comprised Mr. William Brady, Mr. G. Thurnauer, Dr. E. C. Franklin, Dr. W. R. Whitney, Professor J. H. Long, Professor J. Stieglitz, Professor Alexander Smith, Professor W. A. Noyes, Mr. E. B. Bragg, Mr. S. T. Mather, Professor W. H. Walker and Professor T. W. Richards.

At the recent meeting of the American Physical Society at Atlanta, in connection with the American Association for the Advancement of Science, the following officers were elected for 1914: *President,* Ernest Merritt, of Cornell University; *Vice-president,* Karl E. Guthe, of the University of Michigan; *Secretary,* A. D. Cole, of the Ohio State University; *Treasurer,* J. S. Ames, of the Johns Hopkins University; *Members of Council,* G. K. Burgess, of the Bureau of Standards, and D. C. Miller, of the Case School of Science; *Managing Editor of Physical Review,* F. Bedell, of Cornell; *Editorial Board,* A. G. Webster, of Clark University, C. E. Mendenhall, of the University of Wisconsin, and H. A. Bumstead, of Yale University. The next two meetings of the Physical Society will be at Columbia University, New York, on February 28, and at the Bureau of Standards, Washington, on April 24 and 25.

Dr. August Weismann, professor of zoology at Freiburg, celebrated on January 17 his eightieth birthday.

The Imperial Society of the Friends of Natural History, Anthropology and Ethnology, of Moscow, have elected Professor W. M. Davis to permanent membership.

The Imperial Academy of Sciences of St. Petersburg has elected Sir Edward Thorpe as a corresponding member.

Professor Silvanus P. Thompson has been elected a corresponding member of the Academy of Sciences of Bologna.

Professor Johannes Orth, head of the pathological laboratory at the University of Berlin, has been elected an honorary member of the London Institute of Hygiene.

Dr. Joseph T. Rothrock, who is now seventy-four years old, has resigned as a member of the Pennsylvania State Forestry Board after serving for twenty years, in order to devote more time to private work.

Octave Chanute medals have been awarded by the Western Society of Engineers for the best three papers presented during the year 1913 as follows: mechanical and electrical engineering, Mr. W. L. Abbott on "The Northwest Station of the Commonwealth Edison Company"; general engineering, Mr. Onward Bates on "Arbitration"; civil engineering, Mr. D. W. Mead on "The Cause of

Floods and the Factors that Influence Their Intensity."

MONTYON prizes, each of the value of $500, have been given by the Paris Academy of Sciences to Mme. Lina Negri Luzzani, for her studies on the corpuscles discovered in the nervous system of rabid animals, to L. Ambard, for his memoir on renal secretion, and to MM. A. Raillet, G. Moussu and A. Henry, for their researches on distomatosis in ruminants. Awards of $300 each have been made to M. Marquis, for his memoir on mercuric chloride in surgery, to M. Legrange, for his work on the treatment of chronic glaucoma, and to Fernand Bezançon and S. L. de Jong, for their treatise on the examination of sputa.

PROFESSOR W. E. CASTLE, of Harvard University, has been reappointed a research associate of the Carnegie Institution for a period of five years with an annual grant of $2,500 in support of his researches in heredity. This is the third five-year appointment as research associate received by Professor Castle from the Carnegie Institution.

THE American Microscopical Society held only business meetings at Atlanta. Professor Charles Brookover, Little Rock, Arkansas, of the University of Arkansas Medical School, was elected president; Miss Margaret Ferguson, Wellesley College, first vice-president, and Dr. H. L. Shantz, Bureau of Plant Industry, Washington, D. C., second vice-president. T. W. Galloway, of Millikin University, was reelected secretary and editor of the *Transactions*. Mr. Magnus Pflaum, of Meadville, Pa., who has served the society so faithfully for years as its custodian and has built up the research fund to nearly $5,000 was elected to honorary membership.

PROFESSOR CARLOS E. PORTER, director of the *Revista Chilena de Historia Natural* and professor of zoology and entomology at the Agricultural Institut of Chile, has been made vice-president, for 1914, of the Sociedad Cientifica de Chile and honorary professor of zoology at the Agricultural College of the University of Manaos (Brazil).

DR. T. A. JAGGAR, director of the observation station at Kilauea, Hawaii, has gone to Japan, to study the phenomena of the volcanic eruption on Sakura.

DR. J. B. JOHNSTON, professor of anatomy in the University of Minnesota, has sailed for Europe, on leave of absence for the second semester. He will return about September 1.

DR. OTIS WILLIAM CALDWELL, associate professor of botany in the School of Education and dean of University College at the University of Chicago, has been granted leave of absence during the next two months for a visit of inspection to the high schools and colleges of the south with reference to the teaching of science.

LLOYD W. STEPHENSON, of the United States Geologial Survey, is to be at the University of California from January to June, 1914, as acting professor of paleontology, during the half year's absence of Professor J. C. Merriam, who is spending this semester preparing for the publication of some of the results of his collections from the pleistocene asphalt beds of Rancho LaBrea, near Los Angeles.

MRS. HUNTINGTON WILSON has established for the year 1914 a lectureship in eugenics, and has placed a fund of $2,500 for the purpose in the care of the Eugenics Record Office of Cold Spring Harbor, N. Y. Mr. A. E. Hamilton, of Clark University, has been appointed to this lectureship and will be available for colleges, societies and clubs.

PROFESSOR GEORGE C. WHIPPLE, of Harvard University, delivered a lecture on "Relative Values in Sanitation" before the Science Club of the University of Wisconsin on January 22, 1914.

PROFESSOR ARTHUR H. BLANCHARD, in charge of the graduate course in highway engineering at Columbia University, on January 26 delivered illustrated lectures at the University of Illinois on the subjects: "Bituminous Surfaces and Bituminous Pavements" and "Modern Developments in Highway Engineering in Europe."

PROFESSOR GEO. GRANT MACCURDY, of Yale, delivered the fourth of the winter series of

public lectures under the auspices of the Pennsylvania State Museum and the Harrisburg Natural History Society at Harrisburg, Pa., on January 21, 1914. He lectured upon "The Antiquity of Man in the Light of Recent Discoveries."

Dr. Mayville W. Twitchell, the assistant state geologist of New Jersey, has just finished a course of five lectures on "The Geology of New Jersey" before the combined classes of the department of geology at Rutgers College.

Professor Baldwin Spencer lectured on January 27 before the Royal Anthropological Institute on the life of the Australian tribesmen. The lecture was illustrated by means of kinematograph films and phonograph records.

Mr. Alexander George McAdie has been given the title Abbott Lawrence Rotch professor of meteorology, in memory of the late Professor Rotch.

A committee has been formed to establish scholarships in memory of Lord Avebury at the University of London. The sum of $15,000 has already been subscribed for this purpose.

The centonary of the birth of Claude Bernard was celebrated at the Collège de France on December 30.

The tablet unveiled at King's College by Lord Rayleigh on January 14 to the memory of Lord Lister bears the following inscription:

In affectionate and respectful memory of Joseph Baron Lister, F.R.S., O.M., professor of clinical surgery in King's College from 1877–1892, and for many years consulting surgeon to the King's College Hospital, member of the council and life governor of the college, this tablet is erected. His name will be handed down to posterity as the founder of antiseptic surgery, one of the greatest discoveries in history, and a source of inestimable benefit to mankind.

Mr. W. D. Marks, professor of mechanical engineering at the University of Pennsylvania from 1876 to 1887, later a consulting engineer in New York City, has died at the age of sixty-four years.

Professor Aaron Hodgman Cole, of the Chicago Normal School, known for his writings and lectures on biology, has died at the age of fifty-seven years.

The death is announced of Dr. J. Schreiner, astronomer in the Potsdam Astrophysical Observatory.

The late Edward Ginn has bequeathed $800,000 for the World's Peace Foundation which he had established; Tufts College receives $10,000 and one tenth the residue of his estate.

The Swedish Antarctic committee, an association formed last year with Admiral Palander at its head, has planned an expedition which will start in the autumn of 1915. The cost of the expedition will be $72,360.

Dispatches from Dr. Percival Lowell at his observatory at Flagstaff, Ariz., announce that he is using the forty-inch Clark reflecting telescope on Mars with full aperture. The definition he declares to be perfect, the canals being sharp lines.

An organization dinner for the discussion of plans for the International Electrical Congress at San Francisco in September, 1915, is to be held at the Engineers' Club, New York City, Wednesday evening, February 25.

Arrangements are being made for an exhibition of physical apparatus at the joint meeting of the American Physical Society and of the electrophysics committee of the American Institute of Electrical Engineers, to be held on April 24 and 25 at the Bureau of Standards, Washington. The opening of the new electrical building of the bureau will add interest to the occasion, and incidentally will furnish abundant room for a large exhibit of apparatus. It is hoped that designers and makers of apparatus will unite to make this a truly representative exhibition. Unfortunately expenses of transportation and mounting of exhibits must be borne by the exhibitors. The Bureau of Standards can give only a limited amount of help in mounting. Exhibits of any considerable size should be unpacked and mounted, and repacked and cared

for by the exhibitors. Any packages or boxes sent to the Bureau of Standards should be clearly marked "for Physical Society exhibit" and *prepaid.*

FORESTERS and lumbermen see in a decision of the Treasury Department in regard to the administration of the income tax a strong argument for forestry. As they interpret the opinion of the treasury officials they understand that no timberlands shall be subject to the tax until the lumber is cut and marketed and that then the profit only will be subject to an income tax assessment. In other words, all costs will be deducted before the tax is levied, and these will cover the cost of growing the timber, including the cost of planting where necessary and of protecting the growing crop from fire and other depredation. This decision was based upon a request for information made by P. S. Ridsdale, secretary of the American Forestry Association. He asked if there would be a tax on the value of the yearly growth of timber whether it was cut or not, and also whether an income tax would be assessed on the values of the timberland. In reply, the Treasury Department said that the gain from the cutting and disposal of stumpage is realized in the year during which the timber is cut and disposed of, and that the amount received in excess of the cost of such timber is profit, and should be so accounted for as income for that year.

UNIVERSITY AND EDUCATIONAL NEWS

THE late Morrill Wyman, of Cambridge, has left to Harvard College $50,000, to be used to promote good citizenship by the study of republican government. Further, one half of the residue of his estate, which is said to be large, is left to Harvard to establish a fund in memory of his father, to be known as the Morrill Wyman Medical Research Fund, to provide for the study of "the origin, results, prevention and treatment of disease." A further sum of $50,000 will ultimately go to this fund. Another fourth of the residue of the estate is left to the Massachusetts Institute of Technology, to be used in aid of deserving and promising students.

THE gift of $125,000 by an unknown friend for a children's department has now completed the fund of $615,750 which has been raised for building a new teaching hospital for the University of California Medical Department. Among the other principal contributors are John M. Keith, of San Francisco, who has given $150,000 in memory of his wife, and four members of the Crocker family, who have given $150,000 in memory of George Crocker, himself the founder of the Crocker cancer research fund of Columbia University. The givers of the George Crocker fund are Mrs. Harriet F. Alexander, $50,000; William H. Crocker, $50,000; Charles Templeton Crocker, $25,000, and Mrs. Malcolm Whitman, $25,000.

THE University of Chicago will erect three new buildings this year at a cost of $800,000. They are the women's gymnasium and club, the geology building and the classics building. Announcement has been made that building operations will be started so that cornerstones of the geology and classics buildings may be laid at the March convocation.

WITH the object of stimulating interest in scholarship among high school students of the community, four competitive scholarships have been established in Adelbert College of Western Reserve University.

THE sixth session of the graduate school of agriculture will be held at the College of Agriculture of the University of Missouri, beginning on June 29, 1914, and continuing four weeks. Only persons who have completed a college course and taken a bachelor's degree will be admitted to the privileges of the school, except that admission may be granted to non-graduates who are recommended by the faculties of the college with which they are associated as persons properly qualified to profit by advanced instruction in agriculture. The faculty will include leading scientific men and experts from the U. S. Department of Agriculture, the agricultural colleges and experiment stations, and other universities, colleges and scientific institutions in America and Europe.

MERRITT BERRY PRATT, now deputy supervisor of the Tahoe National Forest, has been

appointed assistant professor of forestry in the University of California, in the new department of which Walter Mulford, now professor of forestry at Cornell, is next August, to become the head.

Dr. Albert N. Gilbertson has charge of the instruction in anthropology at the University of Minnesota in the absence on leave of Dr. A. E. Jenks.

Dr. Oscar Perron, of Tübingen, has been called to a professorship of mathematics at Heidelberg.

DISCUSSION AND CORRESPONDENCE

WHAT WAS THE CAUSE OF THE ESKERS?

To the Editor of Science: Eskers are features of the earth's surface well known to all students of glacial phenomena. They are more or less well defined ridges composed of mixtures of sand, gravel, clay and boulders, having a direction generally parallel to that of the movement of the latest ice sheet that covered the region where they occur, or normal to the front boundary of the sheet, and they often have a length of many miles, though entire continuity rarely exists throughout the length of any one such ridge or series of ridges having such relations as to be considered as one esker. In some cases such ridges have a striking uniformity in height and cross section, with an abruptness of side slopes and an alignment that suggest an artificial embankment like that for a railroad or a levee. Other forms that have been called eskers are flattened and spread out, broken into detached ridges that often depart from parallelism, and these are frequently associated with knolls and irregular hummocks and valleys that would not be considered as related in any way to esker forms if they stood by themselves. Eskers in the United States have been described and illustrated in several publications of the United States Geological Survey, as well as in various papers and geological text-books. They are numerous and extensive in the eastern part of that portion of North America that was covered by the latest ice sheet, particularly in Maine, New Brunswick and the eastern Canadian provinces. Several examples on a smaller scale are found in the Great Lakes region of the United States. The writer has examined more especially the eskers near Circleville, south of Norwalk, and near Kenton, in Ohio; the one north of Muncie, Indiana, the fine example near Kaneville, Ill., and the strikingly uniform and conspicuous esker ridge at Mason in southern Michigan. Casual examination has also been made of similar ridges in Ontario, Canada.

The theory to account for these ridges which is most often met with is that they were formed by stream action, in crevices or in tunnels under the ice, during the period of recession or withdrawal of the ice sheet. From the published descriptions and views and sketches of eskers and from the examinations above referred to, I became satisfied that this theory was untenable, although there are some evidences that stream action has had a secondary and modifying effect on the final esker forms in some cases. I concluded that the eskers resulted primarily and principally from cracks in an ice sheet of moderate thickness covering approximately smooth and level areas of considerable extent; these cracks becoming the locus of the accumulation of the esker material from the lateral "shove" of the separated parts of the ice sheet under the influence of seasonal changes of temperature. This action resulted in the upheaval and breaking of the ice along the initial crack, and the melting of the resulting broken ice at a rate greater than that of the main ice sheet due to increase of exposed surfaces, with the accumulation of the general surface earthy material as well as that imprisoned within the ice itself along a more or less well-defined line. This earthy material remained, of course, after the ice disappeared, and it was often modified to a greater or less extent by flowing water during the melting of the ice. I prepared a tentative memorandum setting forth this view some three years or more ago, but it was not published. The illustrated supplement of the New York *Times* of November 23 contains a photographic view of a "pressure ridge" in a sheet

of sea ice, taken from Captain Scott's narrative of his South Pole expedition, which recalls the subject to mind. This picture seems to afford a very decided support for the above theory.

I conceive that the conditions under which eskers were formed were similar to those illustrated by this view of a pressure ridge, although in this case the ridge is understood to have been formed in ice resting on water. It is possible that at the time of the formation of the esker ridges the movement of the ice was facilitated by water underlying the sheet over considerable areas, so that the ice was partially afloat at least for portions of each year.

Very pronounced ridges of boulders and other material are formed under weather conditions now existing around the shores of small interior lakes in cold climates by the "push" of the ice that covers the lakes each winter.

I believe that the seasonal variations in temperature that must have occurred even during the low average temperature of the glacial period, with resulting changes in the internal structure and movements of the ice, constituted an influence of more importance in connection with general glacial phenomena than has heretofore been recognized.

The "trough" or depression along one or both sides of the ridge which sometimes occurs as a marked feature in connection with an esker was probably due primarily to the greater scooping and shoving effects of the ice on the underlying earth material immediately adjacent to the ridge, on account of the broken condition of the ice and the increased weight resulting from increased thickness and the superimposed broken blocks and fragments. The esker ridge itself and such side depressions would sometimes determine or materially modify the immediate post-glacial drainage of the locality, when the depressions would become still further emphasized by stream erosion during and after the melting of the ice. Furthermore, the "delta formation" sometimes found near the end of the esker is thus explained.

A theory similar to the above is applicable to certain irregular detached groups of knolls or hummocks and short ridges with intervening troughs and hollows, called *kame* areas. Some examples of these may mark a sort of focus for the lateral shove from various directions of the surrounding ice sheet. In at least one locality that has been studied in considerable detail the assumption of the formation of an interglacial ridge by a process similar to that described above, but with a direction transverse to that of the general movement of the ice sheet, seems to afford a clue to an explanation of several surface features of the vicinity, and possibly this may also apply to some special cases where there has been difficulty in fitting the terminal moraine theory with entire satisfaction.

The probability of an extensive ice sheet of moderate thickness in comparison with that of earlier ice "invasions" of the same area, and as the final stage of the glacial period for the region in question, suggests other interesting deductions in connection with the causes of present surface forms.

JOHN MILLIS

November 25, 1913

MATTER AND MEMORY

ON reading with interest the article of Professor R. D. Carmichael, SCIENCE, December 19, I find on page 869 a statement which can not pass as entirely general: " . . . mind . . . has chosen to assume that matter is without memory."

While in abstract reasoning we prefer to assume that matter has no memory, nevertheless we well know that in all too many cases this assumption is made for simplicity, not for exactness. The existence of zero drift, permanent set, elastic, magnetic and dielectric hysteresis, etc., so complicates the actual conditions, by making them dependent on the previous experiences of the material under consideration, that we can not set up ideally exact general equations. The complications are by no means as overwhelming as those, for example, which present themselves in dealing with warm-blooded animals, but they are real. What the instrument-maker desires is matter which does forget, whether he be interested in galvanometer suspensions or transformer cores. To speak figuratively, the suspension "re-

members" previous torsion, and precision is impaired; the iron "remembers" the preceding cycle, and energy is wasted in concentrating its wandering attention.

Not the least remarkable thing about falling stones, and gravitational action in general, is the lack of hysteresis, or memory.

WILLARD J. FISHER
NEW HAMPSHIRE COLLEGE,
DURHAM, N. H.

LAG AND LEAD WITH A BRAUN TUBE

IN arranging an experiment to show lag and lead with a Braun tube I hit upon a method that was very effective and may possibly be of use to others.

The tube, with its axis horizontal, was excited by an induction coil with a break of variable speed. Two coils were used to produce the magnetic field, one with its axis vertical, and the other with its axis horizontal, and both with axes perpendicular to the axis of the tube. The distance of the one coil from the tube could be varied. If an alternating current was sent through the coil with horizontal axis it would produce a vertical line on the fluorescent screen when the tube was excited. If now the period of the vibrator of the coil was changed until the frequency of the alternating current was nearly equal to a multiple of the frequency of the coil the stroboscopic effect would make the spot of light move slowly up and down on the screen. With the current flowing through the other coil the spot would move back and forth on the screen. When the alternating current from the same source is led into both coils the spot moves up and down diagonally at an angle of 45°.

If now considerable inductance is introduced into one circuit the spot will move around in an ellipse in one direction, but if a condenser takes the place of the inductance the spot moves in an ellipse in the *opposite* direction. Varying the inductance varies the width of the ellipse so that the amount of lag or lead is roughly indicated. If both inductance and capacity are put into the same circuit the width of the ellipse is reduced, showing the neutralizing effect of capacity on inductance.

JOHN FRED. MOHLER
DICKINSON COLLEGE,
November 28, 1913

A SECOND OCCURRENCE OF ICHTHYOSAURIAN REMAINS IN THE BENTON CRETACEOUS

IN 1905[1] Dr. John C. Merrian announced the discovery of Ichthyosaur-like remains in the Benton of Wyoming. That it was not an accidental occurrence now appears to be indicated by the finding of a second specimen in these same beds. Recently I have received for examination a single badly worn vertebral centrum, collected during the summer of 1913 by Mr. C. J. Hares, of the U. S. Geological Survey in the Mowrey shales, some 12 miles west of Casper, Wyoming. This vertebra is of the typical biconcave ichthyosaurian type and in its present condition is indistinguishable from those of *Baptanodon*. The fragmentary nature of the specimen precludes the possibility of determining its true generic affinities, but as recording a second occurrence of ichthyosaur-like remains in the Benton, the specimen is at the least of interest.

CHARLES W. GILMORE
U. S. NATIONAL MUSEUM

A MISNAMED PORTRAIT OF JOHN SHAW BILLINGS

TO THE EDITOR OF SCIENCE: Dr. S. Weir Mitchell's appreciative memoir of the late Dr. Billings in your current issue is not accompanied by a picture and does not refer to one; so the present note may be acceptable. On p. 223 of Vol. VII. of the "Photographic History of the Civil War" the upper right portrait represents Dr. Billings during the war as an assistant surgeon with the rank of first lieutenant; it is misnamed "Brevet Lieut. Col. J. J. Woodward." This legend really belongs to the lower left portrait, which in turn is misnamed "Brevet Major C. B. Greenleaf." To which of the two other portraits this belongs I can not say. In this connection may be noted another error in the work above named. In Vol. X., on p. 263, the portrait named "David R. Jones" is that of Samuel

[1] SCIENCE, N. S., Vol. XXII., No. 568, pp. 640–641.

Jones, identical with that in his book, "The Siege of Charleston." BURT G. WILDER

BROOKLINE, MASS., December 12, 1913

SCIENTIFIC BOOKS

Researches in Magneto-Optics, With Special Reference to the Magnetic Resolution of Spectrum Lines. By P. ZEEMAN. (Macmillan's Science Monographs.) London: Macmillan and Co., Ltd. 1913. Pp. xvi + 219 + viii plates.

Since the discovery by Zeeman in 1896 of the resolution of spectrum lines in the magnetic field, works have appeared at intervals which summarized the development of the subject to the date of publication. Each of these has been needed when it appeared, partly by reason of differences in treatment by the several authors, but chiefly because of the continuous output of new matter, both on the experimental and theoretical sides; so that an author, by the time his book was off the press, would welcome an opportunity to add numerous footnotes or an extensive appendix.

The investigation of the Zeeman effect during these seventeen years impresses one as having been very ably conducted. The immediate development of the elementary theory by Lorentz gave the phenomenon the place in relation to the theories of light and of electricity which it has ever since maintained. Although the demands on instrumental equipment are severe, the rich field and the close connection with theory caused investigations to be taken up in many laboratories and the requirements have greatly stimulated the development of optical methods. In some cases, theory has predicted a result which at once appeared when the experiment was tried. On the other hand, if one compares the original explanation of the normal triplet with the involved mathematical treatments employed to account for the complex resolutions, the pressure exerted on the theorists by the laboratory results is quite apparent. The development of the theory, however, has been one of growth from a beginning still regarded as sound.

In the book under review, Professor Zeeman has given us an account, simple in language, largely historical in arrangement, and occasionally touched with personal reminiscence, which records in a highly attractive manner the main features of the investigations started by his discovery. It is in keeping with the title and with the series of monographs to which this book belongs that the author devotes his closest analysis to those features of the phenomenon which have been studied in his own laboratory. This involves the correlation of his results with those of others on these subjects, but other important lines of investigation, such as the application to spectral series, are not omitted.

The first chapter is devoted to the instrumental means employed in the study of the Zeeman effect, especially as regards the efficiency of different spectroscopes in giving the high resolving power required. Emphasis is laid on the three requirements of great resolving power, high magnetic field-strength, and sharpness of spectrum lines for the best results in this work. At the close of the chapter we are reminded of what has occurred to many investigators, that we are near the limit of field strength to be obtained from an iron-cored magnet, and that the hope of great advance, both as to intensity and uniformity of field, lies in the use of a large solenoid. Although the construction of this would require a larger expenditure than has ever been devoted to a single line of physical research, the certainty of the results would seem to make the adoption of the method only a question of time.

The early investigations on emission spectra and the derivation of e/m from the separation of the normal triplet are treated in the second chapter, and the author passes next to the "inverse effect," or the magnetic resolution of absorption lines. This branch of the study must be regarded as still in a preliminary stage. A decided stimulus has been given to the examination of the inverse effect by the discovery of the magnetic field in sun-spots, and much important work, described in a later chapter, has been done by Zeeman himself. The methods are quite different from

those employed with emission spectra and the difficulties arise from peculiar causes. The close analogy of the effects with those of bright line spectra is well worked out, however, and we must admire the skill shown in tracing out the action of polarization of the white light and varying density of the absorbing vapor in altering the effects.

In the following chapters, several branches of investigation of the Zeeman effect are considered in turn. A short account is also given of the related phenomena of magnetic rotation in vapors and magnetic double refraction. The study of multiple resolutions is traced, from the observation that all lines are not normal triplets to the profoundly significant relation of the commensurability of the components given by Runge. Dissymmetries in the resolution and a shift of the middle component are features of the later study which are reviewed by Zeeman.

A chapter on solar magneto-optics summarizes the results of the study of the magnetic field of sun-spots by Hale and of his first observations on the general field of the sun. This is followed by a chapter describing the important experiments of Zeeman and Winawer on the inverse effect in directions inclined to the field. Undertaken because of its application to the solar magnetic effects, this work has been carried out with the highest skill and resourcefulness. Results have been obtained which undoubtedly bear closely on the solar phenomena and can be applied when sun-spots are again in evidence.

The closing chapter of the monograph, on the relation between magnetic resolution and the chemical nature of the elements, may be characterized as a statement of unsolved problems. In it we are made to feel how young the subject of magneto-optics is, and that in some directions the considerable mass of experimental material has served to show that a connection with other departments of knowledge exists but leaves the nature of the relation highly obscure. Thus, the relation between magnetic resolution and arrangement of the lines in series is clear only for a few elements having low atomic weights and few lines in their spectra. The fact that a series line which is double with no field may change to a simple triplet in the field is an anomaly which affects the whole question of the connection with series relations. There is probably a fundamental relation between magnetic resolution and the pressure effect, but no close correspondence in detail.

A summary of the leading features of several atomic theories and a highly useful bibliography, giving the entire literature arranged according to year of publication, close a volume which will be appreciated by every student of the subject.

ARTHUR S. KING

MT. WILSON SOLAR OBSERVATORY

Mountains, their Origin, Growth and Decay. By JAMES GEIKIE, LL.D., F.R.S., etc. Edinburgh, Oliver and Boyd. 1913. Pp. 311, 80 Pl., 57 Figs. in text.

This volume contains in systematic form the substance of various contributions made by Professor Geikie during the last twenty years, supplemented with much new matter. The author recognizes two classes of mountains, original or tectonic, and subsequent or relict.

Tectonic mountains are due to accumulation or deformation; the former includes the various types of volcanoes as well as glacial and æolian hills; all of which grow by additions to the outside; the latter includes folded, dislocation and laccolith forms, all due to crustal disturbance. The study of tectonic mountains occupies by far the greater part of the work, which is intended to be a non-technical presentation of the subject. Such matters as glacial action, metamorphism, types and causes of folding, structure of the Alps, origin of ocean "deeps" are discussed as simply and easily as though they were familiar topics of every-day conversation. Certainly, this mode of treatment shows that exact scientific method does not require much aside from ordinary language, for one knowing only the general principles of physics and geology can grasp the situation so as to appreciate the difficulties with which an investigator must contend as

well as the great opportunity for erroneous conclusions. The geologist, finding the statements exact, can not complain because the presentation is such as to be attractive to the layman. Subsequent mountains, being merely relics of former highland, receive briefer treatment, and the discussion is confined chiefly to consideration of the various destructive agencies and their action upon the rocks and types of structure.

As one should expect in a work intended mostly for "home consumption," full share of the space is given to such Scottish and English areas as afford proper illustrations; but in this, as in earlier works by Professor Geikie, there is ample evidence of intimate acquaintance with conditions elsewhere, and he has levied contributions upon all parts of the world. The plates, reproductions of photographs from many lands, are of unusual excellence and the text is full of suggestive matter for the geologist in every land.

Some portions of the work are deliciously controversial; the consideration of phenomena in the Pacific basin is thorough and the argument against explanations offered by Suess is put very strongly; some American geologists will regard the opinions respecting isostacy as not altogether orthodox, and several continental geologists will feel convinced that the author does not know so much about Alpine structure as they do. But all, whether accepting or opposing his conclusions, will agree that the tone of his presentation is judicial throughout, as benefits one who has made direct study in a great part of Europe and whose familiarity with the literature is equalled by that of few other geologists.

John J. Stevenson

The Indigenous Trees of the Hawaiian Islands. By Joseph F. Rock, botanist of the College of Hawaii; consulting botanist, Board of Commissioners of Agriculture and Forestry, Territory of Hawaii. Issued June 26, 1913. With two hundred and fifteen photo-engravings. Published under patronage. Honolulu, T. H. 1913. Large octavo. Pp. viii + 518.

This stately volume includes descriptions of two hundred and twenty-five species of trees which are natives of the Hawaiian Islands. The author tells us in his preface that it had "long been the writer's desire to give to the public a volume on the nativo trees of Hawaii," so that this work is the result of a protracted study of the interesting vegetation of these isolated islands, and as a consequence is much more authoritative and complete.

The introduction, of 87 pages, gives "a more or less detailed description of all the floral regions, and their plant associations found in this island group, not being restricted to trees alone, but embracing the whole plant covering." In it we are first given a tabular enumeration of the botanical regions, as follows:

1. Strand vegetation.
2. Lowland region (merging into 3).
    (a) Dry region.
    (b) Wet region.
3. Lower forest region.
    (a) Windward side.
    (b) Leeward side.
4. Middle forest region.
    (a) Dry region.
    (b) Semi-dry region.
    (c) Wet region.
    (d) *Kipukas* (small areas of black, fertile soil in dry regions with no trace of lava, richest in species).
5. Bog region.
6. Upper forest region.

These are described at some length, and are illustrated by many good photo-engravings. On the largest of the islands (Hawaii) the mountains reach elevations of 8,273 feet, 13,675 feet and 13,823 feet, so that there are wide climatic ranges from tropical heat to "almost perpetual snow." Indeed the author sums up his statement in the sentence, "from a phytogeographic standpoint the island of Hawaii offers the most interesting field in the Pacific."

Coming now to the systematic part of the book one finds that no less than forty-five families of plants are represented by species of trees. And yet with all the variety that this implies there is scarcely a familiar genus in

the whole book. There are two tree ferns, of the genus *Cibotium*, one (*C. menziesii*) reaches a total height of 26 feet and its stem often has a diameter of three feet. Monocotyledons are represented by a *Pandanus*, eleven palms (*Pritchardi* and *Cocos*) and a *Dracaena*. In the Dicotyledons one finds many unfamiliar genera in familiar families: as *Trema* (Ulmaceae), *Urera* and *Pipturus* (Urticaceae), *Nototrichium* and *Charpentiera* (Amaranthaceae), *Broussaisia* (Saxifragaceae), *Colubrina* (Rhamnaceae), *Jambosa, Syzygium,* and *Metrosideros* (Myrtaceae), *Pteralyxia, Ochrosia* and *Rauwolfia* (Apocynaceae), *Clermontia* and *Cyanea* (Campanulaceae), *Dubautia, Raillardia,* and *Hesperomannia* (Compositæ). On the other hand one finds, also, *Artocarpus* (Moraceae) the well-known "Breadfruit tree"; *Pittosporum* (Pittosporaceae), of which there are twelve species, several of which are more than twenty feet high; *Acacia* and *Sophora* (Leguminosae); *Xanthoxylum* (Rutaceae); *Euphorbia* (Euphorbiaceae), two species of trees from 15 to 25 feet in height; *Rhus* (Anacardiaceae); *Ilex* (Aquifoliaceae), one tree of 20 to 40 feet in height; *Hibiscus* (Malvaceae), including trees 20 to 30 feet in height; *Sideroxylon* (Sapotaceae), some 50 to 60 feet high; *Osmanthus* (Oleaceae), sixty feet high; *Solanum* (Solanaceae) a small tree, 15 to 20 feet high. Many of the trees bear foliage of such a structure as to hide completely their botanical relationship.

Among the notable trees is the koa (*Acacia koa*), "one of our most stately trees." "It is perhaps the most valuable tree which the islands possess, as it is adapted for construction as well as for cabinet work. The koa reaches a height of more than 80 feet in certain localities, with a large trunk vested in a rough, scaly bark of nearly an inch in thickness." Another tree (*Pisonia umbellifera*) possesses so soft a stem that "trunks of a foot in diameter can be felled with one stroke of the axe."

The largest family, so far as the tree species are concerned, is Rutaceae (32 sp.), followed closely by Rubiaceae (31 sp.), and then Campanulaceae (15), Araliaceae (14), Pittosporaceae (12), Palmaceae (11), Myrsinaceae (11), and Malvaceae (10).

At the end of the volume there is a good index to the scientific names, followed by one of the Hawaiian and few English names.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

Science from an Easy Chair. Second series. By SIR RAY LANKESTER. New York, Henry Holt and Company. 1913. Pp. 412.

In his chapter on Museums, Sir Ray Lankester deplores the fact that so many are "mere enlargements of the ancient collector's 'cabinet of rare and curious things,' brought together and arranged without rhyme or reason." His book, dealing in one small volume with such diverse matters as Kisses, Ferns, Glaciers, Elephants and Tadpoles, might possibly be described in similar terms; yet it is by no means without merit. It is a significant and interesting fact that a zoologist of the first rank, retiring from the directorship of the British Natural History Museum, should think it worth his while to contribute weekly articles on scientific subjects to a daily paper, regularly for a period of five years. It is no less significant that this paper (the *Daily Telegraph*) should be willing to print them as they stand, popular in form, but dealing in many cases with technical matters which require close attention in order to be understood. The book before us consists of a selection from this newspaper series, with some revision and expansion, and a number of illustrations. It possesses the original journalistic tone, and consists essentially of well-written dissertations on matters familiar to specialists, but, for the most part, new to the general public. I have read the greater part of it with pleasure and interest, and, while different chapters will appeal to different people, few can fail to find something of value. Some of the essays, as those on Food and Cookery and Misconceptions about Science, reflect so strongly the author's prepossessions that they naturally arouse a combative spirit in those of a different temper. Here and there, expressions have crept in which the author would scarcely de-

feud in cold blood; thus (p. 19) "even the destructive bacteria which are killed by the sun probably enjoy an exquisite shudder in the process which more than compensates them for their extinction"; and (p. 344) "every step which he [the house-fly] takes he plants a few dozen microbes, which include those of infantile diarrhœa, typhoid and other prevalent diseases,"—a gross exaggeration in a chapter which very properly calls attention to the great harm done by flies as carriers of bacteria.

The time has certainly come for scientific men in America to attack the problem of scientific journalism in an organized and deliberate manner. The individual naturalist is more or less helpless. When I was curator of the museum in Jamaica I contributed weekly articles to the newspapers of Kingston, which printed them as written, and even illustrated them when requested. These articles interested a good many people and were the cause of many visits and contributions to the museum. In Colorado I have tried the same thing, and given it up in despair. The papers will not print things accurately or in full, and will often supply headlines of the most ridiculous kind. Here is a typical incident. A friend of mine shot a large eagle and measured it from tip to tip of the wings. Thinking the matter of interest, he handed in the item to a daily paper. The editor, with the best of intentions in the world, added a foot to the measurement, with the result that my friend appeared to those who knew anything of eagles a remarkable liar! These troubles are not confined to the wild and woolly west. Even the *Outlook*, certainly one of our best-edited journals, recently published an article on A. R. Wallace which contained in the first column a number of errors concerning the best-known facts of his life.

It is not true, of course, that the newspapers *always* select incompetent writers on scientific subjects, or *always* distort accurate information communicated to them; but if they are to be the means of enlightening the public concerning the discoveries of science, they must *never* do these things, except through such unfortunate accidents as can not perhaps wholly be avoided. One can not write to the papers if the chances are one in five or ten that one will be exhibited as a fool or liar, and the public misled as to the facts.

T. D. A. COCKERELL

SPECIAL ARTICLES

A NOTE ON SEX DETERMINATION[1]

OF the many hypotheses that have been advanced to explain the determination of sex, one group seeks to show that in bilateral animals the sex of the offspring is dependent upon the right or left source of the effective genital element in that right glands produce offspring of one sex, left glands those of the other. Such a general theory may be applied, of course, to either the ovary or the testis. Thus Seligson (1895)[2] formulated the hypothesis that in mammals the right ovary gives rise to eggs that produce male offspring, the left to eggs that produce female offspring.

In collecting a body of data to show the relation of the size of litters to the number of nipples in swine (Parker and Bullard, 1913),[3] certain facts appeared which have a bearing on such hypotheses. The records brought together in this connection included the position that the young pigs occupied in the uterus and their sex. In reasonably large litters it was therefore possible to make a rough comparison of the products of one ovary with those of the other by contrasting the young pigs in one horn of the uterus with those in the other. The possibility of the migration of an egg from one side of the body to the other could not be excluded, but to reduce to a minimum the effect of this on the statistics and to make the comparison as striking as possible, the

[1] Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College, No. 245.

[2] Seligson, E., "Zur Bestimmung und Entstehung des Geschlechts," *Centralbl. für Gynäkol.*, Bd. 19, pp. 590–595, 1895.

[3] Parker, G. H., and C. Bullard, "On the Size of Litters and the Number of Nipples in Swine," *Proceed. Amer. Acad. Arts and Sci.*, Vol. 49, pp. 397–426, 1913.

whole contents of horns were not compared, but the pairs of animals next the right and the left ovaries were contrasted, so far as their sexes were concerned, with the pairs at the junction of the horns, the presumption being that the pure products of each ovary would occur most frequently next that organ and the mixed products of the two ovaries midway between them. The details thus brought together are shown in the following table.

TABLE

This table shows the frequency of occurrence of pairs of unborn pigs of various combinations of sexes at the division of the horns of the uterus, next the right ovary, and next the left ovary.

Composition of Pairs		♂♂	♀♀	♂♀
Observed frequencies	At division of horns	252	240	456
	Next right ovary	228	209	434
	Next left ovary	216	208	447
Percentage frequencies	At division of horns	26.6 –	25.3 +	48.1 +
	Next right ovary	26.2 –	24.0 –	49.8 +
	Next left ovary	24.8 –	23.9 –	51.3 +

It is fair to assume that at the division of the horns of the uterus the offspring are likely to be as often from one ovary as from the other. If in the whole population the males and females are equally abundant, three classes of pairs would be expected to occur and in the following proportions: 25 per cent. of the pairs would be composed of two males; 25 per cent. of two females; and 50 per cent. each of a male and a female. That this condition is very nearly realized is seen from the table, where it will be observed that the pairs of males are present to the extent of 26.6 — per cent., the females 25.3 + per cent. and the pairs of the two sexes combined 48.1 + per cent. The fact that the table shows a few more pairs of males than females is due to the condition of the population as a whole, in which the males outnumber the females by 1,026 to 1,000. This slight digression from equality also has its effect on the relation of the numbers of pairs composed of both sexes to those of one sex only, but the total number of records is probably too small to yield very smooth results in this respect.

If, as Seligson maintained, the right ovary gives rise to male and the left to female offspring, the pairs of pigs next the right ovary ought to be predominantly males and those next the left predominantly females. That such is not the case is seen at once from the table, where it is shown that pairs composed of two males or of two females occur in about the same proportions next the right ovary that they do next the left, a proportion that is very close to that occurring at the division of the horns of the uterus. These statistics, therefore, give no support to hypotheses, such as Seligson's, according to which the eggs from the ovary of one side of the body produce offspring of one sex only.

Although the sex of the offspring is thus shown not to be correlated with the side of the body from which the egg that gave rise to the young came, it might be supposed that in any female a given ovary would always produce offspring of the same sex. In that case we should expect to find the great majority of pairs of young next the ovaries to be either both males or both females. But, as the table shows, there are almost as many pairs composed of one male and one female next the ovaries as there are at the division of the horns. Hence we may conclude that in the pig the ovaries by virtue of their position in one or other half of the maternal body exert no influence on the sex of the offspring, but that each ovary produces eggs which may give rise to either male or female offspring. This conclusion is in line with such experimental work as that of Doncaster and Marshall (1910),[4] and of King (1911)[5] on albino rats, according to which a single ovary, after the removal of its mate, can give rise to eggs which produce males and females.

G. H. Parker

January 23, 1914

[4] Doncaster, L., and F. H. A. Marshall, "The Effects of One-sided Ovariotomy on the Sex of the Offspring," *Jour. Genetics*, Vol. 1, pp. 70–72, 1910.

[5] King, H. D., "The Effects of Semi-spaying and Semi-castration on the Sex Ratio of the Albino Rat (*Mus norvegicus albinus*)," *Jour. Exp. Zool.*, Vol. 10, pp. 381–392, 1911.

THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

FOR a number of years the members of the Physiological, the Biochemical and the Pharmacological Societies have felt the desirability of a closer cooperation of these and other biological societies, especially as regards the annual scientific meetings. At the meeting in Chicago in 1907 the Physiological Society appointed a committee on policy with instructions to report at the next annual meeting. At the meeting in Baltimore in 1908 the chairman of this committee, Dr. A. P. Mathews, presented a plan for reorganizing all the present biological societies into a general Biological Society. The plan involved a change in policy and in the character of the membership of at least some of the societies, and an extensive venture in the publication of scientific journals. These features were not endorsed by the society, but the general plan of affiliation of all the biological societies was favorably received and Dr. Mathews was appointed delegate from the Physiological Society to confer with delegates from the other biological societies to this end. This committee does not appear to have made any progress.

At the meeting in Cleveland in 1912, the Physiological, Biochemical and Pharmacological Societies appointed committees to propose plans for affiliation. The committee consisted of Drs. Meltzer, Lee and Cannon from the Physiological Society, Drs. Lusk, Gies and Wells from the Biochemical Society and Drs. Sollmann, Loevenhart and Auer, from the Pharmacological Society. This committee submitted the following plan:

1. That the three societies affiliate under the name of the Federation of American Societies for Experimental Biology.

2. That the presidents and secretaries of the three societies constitute the executive committee of the federation.

3. That programs of the annual meetings be printed under one cover, and that the secretaries confer and adjust the papers with the view of the greatest coordination.

4. That a common meeting place of the federation with the anatomists, zoologists and naturalists is desirable.

The annual meeting in Philadelphia, December 28–31, 1913, was arranged by the executive committee of the federation according to the above plan. Those present at the meeting were in substantial agreement that it was a success. At this meeting the plan of the organization committee was ratified by the three societies and the Society for Experimental Pathology joined the federation. This brings the total membership of the federation up to about 450.

The distinctive feature of the federation plan is the cooperation and coordination in the essential things, with no interference with the individuality of the societies. This cooperation is certainly desirable between all the biological societies, and we believe the federation plan can and ought to be extended in that direction. We believe it will increase the efficiency of the societies as agencies for the promotion of research and dissemination of truth.

At the first executive meeting of the federation, December 31, 1913, the following declaration on the subject of animal experimentation was unanimously adopted:

1. We, the members of the Federation of American Societies for Experimental Biology—comprising the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology,—in convention assembled, hereby express our accord with the declaration of the recent International Medical Congress and other authoritative medical organizations, in favor of the scientific method designated properly animal experimentation but sometimes vivisection.

2. We point to the remarkable and innumerable achievements by means of animal experimentation in the past in advancing the knowledge of biological laws and devising methods of procedure for the cure of disease and for the prevention of suffering in human beings and lower animals. We emphasize the necessity of animal experimentation in continuing similar beneficent work in the future.

3. We are firmly opposed to cruelty to animals. We heartily support all humane efforts to prevent the wanton infliction of pain. The vast majority of experiments on animals need not be and, in fact, are not accompanied by any pain whatsoever. Under the regulations already in force, which reduce discomfort to the least possible amonnt and which require the decision of doubtful cases by the responsible laboratory director, the performance of those rare experiments which involve pain is, we believe, justifiable.

4. We regret the widespread lack of informa-

tion regarding the aims, the achievements and procedures of animal experimentation. We deplore the persistent misrepresentation of these aims, achievements and procedures by those who are opposed to this scientific method. We protest against the frequent denunciations of self-sacrificing, high-minded men of science who are devoting their lives to the welfare of mankind in efforts to solve the complicated problems of living beings and their diseases.

Executive Committee of the Federation for the Year 1914.—W. B. Cannon, A. J. Carlson, the Physiological Society; G. Lusk, P. A. Shaffer, the Biochemical Society; T. Sollmann, J. Auer, the Pharmacological Society; R. M. Pearce, G. H. Whipple, the Pathological Society; G. Lusk, *Chairman;* P. A. Shaffer, *Secretary.*

A. J. Carlson,
Secretary of the Executive Committee, 1913

University of Chicago,
January 10, 1914

THE AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS

The eighth annual meeting of the American Society of Biological Chemists was held at Philadelphia on December 29, 30, 31, 1913, in affiliation with the American Physiological Society and the American Society for Pharmacology and Experimental Therapeutics, as the first meeting of the Federation of American Societies for Experimental Biology. The meetings of the society were well attended and highly successful. The joint meetings, as in past years, were of great interest to the members of all of the societies, and these, together with the cooperation in the arrangement and printing of programs, emphasized the advantages of the closer relations between the societies made permanent by the formation of the federation. The scientific programs are appended.

First Session.—December 29, 9 A.M., at the Jefferson Medical College. Joint session with the American Physiological Society and the American Society for Pharmacology and Experimental Therapeutics, as the first session of the federation. Presiding officer, S. J. Meltzer, president of the American Physiological Society and chairman of the federation.

Presidential address, "Theories of Anesthesia," by S. J. Meltzer.

"Phlorhizin Glycosuria before and after Thyroidectomy," by Graham Lusk.

"Studies in Diabetes: (1) The Effect of Different Compounds on Glycogenesis"; (2) "The Mechanism of Antiketogenesis," by A. I. Ringer and E. M. Frankel (by invitation).

"Some Problems of Growth: (*a*) The Capacity to Grow; (*b*) The Rôle of Amino Acids in Growth," by L. B. Mendel and T. B. Osborne.

"Further Studies in the Comparative Biochemistry of Purine Metabolism," by Andrew Hunter.

"Changes in Fats during Absorption," by W. R. Bloor.

"Immunization against the Anti-coagulating Effect of Leech Extract," by Leo Loeb. (By title.)

"Anaphylaxis in the Cat and Opossum," by C. W. Edmunds.

"Vividiffusion; Report on Preliminary Results," by J. J. Abel, L. G. Rowntree and B. B. Turner.

"A Method of Dialyzing Normal Circulating Blood and Some of Its Applications," by C. L. V. Hess (by invitation) and H. McGuigan.

"A Biological Test for Iodine in the Blood," by A. Woelfel and A. L. Tatum (by invitation).

"Further Studies of the Excretion of Acids," by L. G. Henderson and W. W. Palmer (by invitation).

Second Session.—December 29, 2:30 P.M. at the Jefferson Medical College. Presiding officer, President A. B. Macallum.

Presidential address, "The Physics of Secretion and Excretion," by A. B. Macallum.

"The So-called Vegetable Proteoses and their Biological Reactions," by H. G. Wells and T. B. Osborne.

"Some Anaphylactic Reactions," by H. C. Bradley.

"The Mode of Action of Soy Bean Urease," by D. D. Van Slyke and Glen E. Cullen (by invitation).

"Glycol Aldehyde in Phlorhinized Dogs," by R. T. Woodyatt. (By title.)

"Trikresol as a Substitute for Toluene in Enzyme Work," by P. A. Kober and S. S. Graves (by invitation).

"A Study of the Metabolism in Osteitis Deformans," by J. C. DaCosta, E. H. Funk, Olaf Bergeim (by invitation) and P. B. Hawk.

"Metabolism in Diabetes Insipidus," by S. Bookman. (By title.)

"Some Metabolic Effects of Bathing in the Great Salt Lake," by H. I. Mattill (by invitation) and H. A. Mattill. (By title.)

"Absorption of Antitoxin from Solutions Containing Different Percentages of Protein,"[1] by W. H. Park, E. J. Banzhaf and L. W. Famulener.

Third Session.—December 30, 9 A.M., at the University of Pennsylvania. Presiding officer, President A. B. Macallum.

"The Carbohydrate Tolerance of Feeble-minded Children, especially of the Mongolian Type," by A. W. Peters and M. E. Turnbull (by invitation).

[1] Transferred from the Pharmacological Society.

"Protein Metabolism in Individuals with Exfoliative Conditions of the Skin," by A. I. Ringer and G. W. Raiziss (by invitation).

"The Oxygen Requirements of Shell Fish," by P. H. Mitchell.

"The Metabolic Relationship of the Acetone Bodies," by W. McK. Marriott.

"Phenomena of Narcosis of Leaves of the Wild Indigo (*Baptisia tinctoria*) and Consequent Prodaduction of a New Phenol," by E. D. Clark. (By title.)

"A Hitherto Unknown Constituent of Nerve Cells," by A. B. Macallum and J. B. Collip (by invitation).

"A Note on the Chemical Constituents of the Cerebrospinal Fluid in Certain Cases of Insanity," by H. M. Adler and B. H. Ragle (by invitation). (By title.)

"On the Estimation of Minute Quantities of Phosphorus," by A. E. Taylor and C. W. Miller (by invitation).

"Formation of Glucose from Citric Acid in Diabetes Mellitus and in Phlorhizin Glycosuria," by I. Greenwald.

"Further Results upon the Electrolysis of Peptides and Amino Acids," by J. P. Atkinson. (By title.)

"Researches on the Heptoses," by George Peirce (by invitation).

"The Nerve Control of the Thyroid Gland." By C. G. Fawcett (by invitation) and J. A. Rahe (by invitation). (Presented by S. P. Beebe.)

Fourth Session.—December 30, 2 P.M., at the medical laboratory of the University of Pennsylvania. Joint meeting with the American Physiological Society and the American Society of Pharmacology and Experimental Therapeutics. Presiding officer, President S. J. Meltzer.

Presentation of Demonstrations

The Influence of the Vagi on Renal Secretion, by R. G. Pearce.

Stimulation of the Semi-circular Canals, by F. H. Pike.

Demonstration of Vividiffusion, by J. J. Abel, L. G. Rowntree and B. B. Turner.

The Determination of Blood Sugar, by P. A. Shaffer.

Intestinal Peristalsis in Homarus, by F. R. Miller.

Methods for Studying the Pharmacology of the Circulation, by C. Brooks.

The Contour of the Intraventricular and the Pulmonary Arterial Pressure Curves by Two New Optically Recording Manometers, by C. J. Wiggers.

Some Time-saving Laboratory Methods, by C. C. Guthrie.

A Graphic Method for Recording the Coagulation of Blood, by W. B. Cannon and W. L. Mendenhall (by invitation).

Some Mutual Relations of Oxalates, Salts of Magnesium and Calcinm; Their Concurrent and Antagonistic Actions, by F. L. Gates and S. J. Meltzer.

A Method of obtaining Successive Contrast of the Sensations of Hunger and Appetite, by A. J. Carlson.

Further Observations on the Pyramidal Tracts of the Raccoon and Porcupine, by S. Simpson.

A New Apparatus for Demonstration of the Dioptrics of the Eye and the Principles of Ophthalmoscopy and Retinoscopy, by A. Woelfel.

Simple Experiments on Respiration for the Use of Students, by Y. Henderson.

Convenient Modification for Venous Pressure Determinations in Man, by R. D. Hooker.

Device for Interrupting a Continuous Blast of Air, Designed Especially for Artificial Respiration, by R. A. Gesell and J. Erlanger.

A Simple Liver Plethysmograph, by C. W. Edmunds.

An Artificial Circulation Apparatus for Students, by W. P. Lombard.

A Simplified and Inexpensive Oxadase Apparatus, by H. H. Bunzel.

An Improved Form of Apparatus for Perfusion of the Excised Mammalian Heart, by M. Dessbach.

Fifth Session.—December 31, 9 A.M., at the University of Pennsylvania. Presiding officer, President A. B. Macallum.

"Biological Oxidizability and Chemical Constitution," by H. H. Bunzel.

"Albuminuria Following Phenolphthalein Ingestion," by J. L. Hydrich (by invitation).

"The Determination of Fats in Small Amounts of Blood," by W. R. Bloor.

"Creatine Determination in Muscle," by L. Baumann.

"A Respiration Chamber for Small Animals," by A. C. Kolls (by invitation) and A. S. Loevenhart.

"A Respiration Incubator for the Study of Metabolism in New-born and Prematurely Born Infants," by J. R. Murlin.

"The Specific Rôle of Foods in Relation to the Composition of the Urine," by N. R. Blatherwick (by invitation).

"Creatinine- and Creatine-free Foods," by Rita K. Chestnut (by invitation). (Presented by A. B. Macallum.)

"Experimental Hydrochloric Acid Intoxication," by S. Bookman. (By title.)

"The Effects of Water-gas Tar on Oysters," by P. H. Mitchell. (By title.)

"The Effect of Glucose on Autolysis: A Possible Explanation of the Protein-sparing Action of Carbohydrates" (preliminary note), by P. A. Shaffer.

"The Passage of Organic Substances from Plant to Medium," by M. X. Sullivan. (By title.)

"Studies on Chicken Fat VI. The Factors Influencing the Acidity of the Crude Fat," by M. E. Pennington, J. S. Hepburn (by invitation) and E. L. Connolly (by invitation).

By Title:

"The Influence of Restricted Rations on Growth," by E. B. Hart and E. V. McCollum.

"Production of Ammonia by Herbivora as a Protection Against Acidosis," by E. B. Hart and E. V. Nelson (by invitation).

"The Influence of Restricted Rations on Reproduction," by E. B. Hart, E. V. McCollum and H. Steenbock.

"Further Studies on the Quantitative Chemical Composition of Urinary Calculi," by J. Rosenbloom.

"On the Quantitative Chemical Composition of Gall Stones," by J. Rosenbloom.

"Metabolism Studies in a Case of Family Periodic Paralysis," by J. Rosenbloom and T. Diller (by invitation).

"Calcium Metabolism in Thyroparathyroidectomy," by F. T. Stewart (by invitation), Olaf Bergeim (by invitation), and P. B. Hawk.

"Variations in the Hydrogen Ion Concentration of the Urine of Man Accompanying Fasting and the Low and High Protein Regeneration Periods," by P. E. Howe and P. B. Hawk.

The following papers submitted in the American Society of Biological Chemists were transferred with the authors' consent and in accordance with the principles of the Federation, to the program of one of the other societies:

Presented before the American Physiological Society:

"The Maximum Surface Tension in Striated Muscle," by W. N. Berg. (By title.)

"Sources of Surface Tension in Striated Muscle," by W. N. Berg.

"Transfusion of Blood in Severe Diabetes Mellitus," by R. T. Woodyatt and B. O. Raulston (by invitation).

Presented before the American Society for Pharmacology and Experimental Therapeutics:

"The Production of Glycosuria by Zinc Salts," by W. Salant and M. Kahn.

"Further Observations of Caffeine Glycosuria," by W. Salnnt and M. Kahn.

"Studies Upon the Long-continued Feeding of Saponine," by C. L. Alsberg and C. S. Smith.

New Members.—Dr. Shiro Tashiro, University of Chicago, Chicago, Ill.; Dr. E. K. Marshall, Jr., Johns Hopkins Medical School, Baltimore, Md.; Professor R. S. Lillie, Clark University, Worcester, Mass.; Dr. K. G. Falk, Harriman Research Laboratory, Roosevelt Hospital, New York; Dr. F. C. Cook, Bureau of Chemistry, Department of Agriculture, Washington, D. C.; Dr. W. H. Eddy, Columbia University, New York; Professor R. F. Ruttan, McGill University, Montreal, Canada; Dr. H. B. Lewis, University of Pennsylvania, Philadelphia, Pa.; Dr. C. J. West, Rockefeller Institute, New York; Dr. E. C. Kendall, St. Luke's Hospital, New York; Dr. G. W. Raiziss, Polyclinic Hospital, 1818 Lombard Street, Philadelphia Pa.; Professor A. D. Hirschfelder, University of Minnesota, Minneapolis, Minn.

Officers Elected.—The following officers were elected for the year 1914:

President: Graham Lusk.

Vice-president: C. L. Alsberg.

Secretary: P. A. Shaffer.

Treasurer: D. D. Van Slyke.

Additional Members of the Council: J. J. Abel, A. B. Macallum, T. B. Osborne.

Nominating Committee.—S. R. Benedict, H. S. Bradley, Otto Folin, W. J. Gies, J. H. Kastle, J. B. Leathes, P. A. Levene, L. B. Mendel, H. G. Wells.

The society voted its formal approval of the establishment of the Federation of American Societies for Experimental Biology, comprising the American Physiological Society, American Society of Biological Chemists and the American Society for Pharmacology and Experimental Therapeutics. The society also voted in favor of admitting to the federation the newly organized American Society for Experimental Pathology.

A unanimous vote of thanks was extended by the society to the individual members of the "local committee," to the University of Pennsylvania and to the Jefferson Medical College for the hospitality which the society enjoyed.

The following members were present at one or more of the sessions of the meetings: J. J. Abel, C. L. Alsberg, S. Amberg, L. Baumann, S. P. Beebe, W. N. Berg, W. R. Bloor, H. C. Bradley, H. H. Bunzel, R. Burton-Opitz, E. D. Clark, F. C. Cook, H. D. Dakin, Willey Denis, W. H. Eddy, Otto Folin, W. J. Gies, I. Greenwald, Shinkishi Hatai, R. A. Hatcher, P. B. Hawk, L. J. Henderson, P. E. Howe, W. H. Howell, R. Hunt, A. Hunter, N. W. Janney, W. Jones, I. S. Kleiner, P. A. Kober, J. B. Leathes, J. Loeb, A. S. Loevenhart, Graham Lusk, A. B. Macallum, J. J. Macleod, W. deB. NacNider, W. McK. Marriott, E. K. Marshall, J. Marshall, E. V. McCollum, F. H. McCrudden, H. McGuigan, L. B. Mendel, P. H. Mitchell, J. R. Murlin, V. C. Myers, T. B. Osborne, A. W. Peters, G. W. Raiziss, A. N. Richards, A. I. Ringer, E. W. Rockwood, L. G. Rowntree, Wm. Salant, F. H. Scott, P. A. Shaffer, T. Sollmann, Shiro Tashiro, A. E. Taylor, F. P. Underhill, D. D. Van Slyke, C. Voegtlin, G. B. Wallace, H. G. Wells, R. T. Woodyatt.

Abstracts of the papers will be published in the *Journal of Biological Chemistry*.

P. A. Shaffer,
Secretary

Washington University
Medical School,
St. Louis, Missouri

THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The 26th annual meeting of the association was held in the Atlanta Medical College, Atlanta, Ga., December 31, 1913, to January 2, 1914, under the presidency of Professor P. J. Parrott, Geneva, N. Y.

The report of the secretary showed that the association was making a healthy growth and that the *Journal of Economic Entomology* was gradually increasing in circulation and that its financial condition was satisfactory.

Prior to the meeting arrangements were made for the incorporation of the association. This was brought about and the association is now incorporated as a membership corporation under the laws of the District of Columbia.

During the meeting the association considered the possibility of securing the publication of a bibliography of economic entomology and a committee was appointed to take charge of assembling the references required, and to investigate the possibilities of publishing this useful work.

Thirty-four new members were elected to the association and the following officers were elected for the ensuing year:

President—Dr. H. T. Fernald, Amherst, Mass.

First Vice-president—Professor Glenn W. Herrick, Ithaca, N. Y.

Second Vice-president—Dr. W. E. Britton, New Haven, Conn.

Third Vice-president—Professor Wilmon Newell, College Station, Texas.

Secretary—A. F. Burgess, Melrose Highlands, Mass.

It was voted to hold the next meeting in conjunction with that of the American Association for the Advancement of Science at Philadelphia next December.

The section on apiary inspection met on January 1 at 10:30 A.M., and was presided over by Professor Wilmon Newell, College Station, Texas. In the absence of the secretary, Mr. N. E. Shaw, Columbus, Ohio, was elected to act as secretary. Several papers were presented and a general discussion followed concerning the apiary inspection work which is being carried on by the different states. At the close of the session the above-mentioned officers were elected for the ensuing year.

The section on horticultural inspection was presided over by Professor E. L. Worsham, Atlanta, Ga., and Professor J. G. Sanders, Madison, Wis., as secretary. The meeting was called to order at 1:30 P.M., January 1, and an adjourned meeting was held at 7 P.M. in the parlors of the Ansley Hotel. A full program of papers was presented at this meeting and many subjects of interest to horticultural inspectors were considered and discussed. One of the most important matters brought before the section was the consideration of a uniform nursery inspection law and more definite standards for inspection of nursery stock, which passes into interstate commerce. The meeting adjourned at 8 P.M., and the following officers were elected to serve for the ensuing year: Dr. W. E. Britton, New Haven, Conn., *Chairman;* Professor J. G. Sanders, Madison, Wis., *Secretary.* At the close of this meeting all visiting entomologists were the guests of state entomologist Worsham and his assistants at a smoker which was held at the University Club. There was a large attendance and all those present united in extending their thanks to the hosts of the occasion.

The program of scientific papers was introduced by the address of President Parrott on "The Growth and Organization of Applied Entomology in United States." This was followed by a series of papers on the organization of various kinds of special entomological work which is being carried on in different sections of the country. On Thursday morning a number of papers were presented bearing on spraying with poisonous and contact insecticides; on fumigation and life history studies on a number of orchard and garden pests. At the afternoon session, papers were read on experimental work on a number of insects which are destructive to garden and field crops and forests, and several papers on insect parasitism were also presented.

At the closing session on Friday morning, January 2, a paper was presented by Dr. L. O. Howard on "The Education of the Entomologist in the Service of the United States Department of Agriculture," and this was followed by a number of interesting papers on mosquitoes and house flies, which took up observations on their habits and experiments bearing on their control.

All the papers presented at the meeting will be published in full in the *Journal of Economic Entomology.*

A. F. BURGESS,
Secretary

THE AMERICAN PHILOSOPHICAL ASSOCIATION

THE association at its annual meeting at New Haven, Conn., in December, elected the following officers:

President—Professor J. H. Tufts, of Chicago University.

Vice-president—Professor W. H. Sheldon, of Dartmouth College.

Secretary-treasurer—Professor E. G. Spaulding, of Princeton University.

New Members of the Executive Committee—Professors W. T. Bush, of Columbia University; I. W. Riley, of Vassar College, and C. M. Bakewell, of Yale University.

The program was of exceptional interest this year, in that two days' sessions were devoted to the discussion of one subject, "The Problem of Values in its Various Aspects." Miscellaneous papers were read on this subject at the first day's sessions, and the entire second day was devoted to discussion. The leaders in this debate were Professor R. B. Perry, of Harvard University, and Professor W. H. Sheldon, of Dartmouth College. The association, on the whole, found this procedure more profitable than the usual short discussions of many miscellaneous papers. A joint discussion was also held with the American Psychological Association on "The Standpoint and Method of Psychology." Leaders in this discussion were Professor John Dewey, Professor F. M. Urban, Professor J. E. Creighton and Professor Hugo Münsterberg. The two associations participated in a joint dinner on December 30 at the Hotel Taft, and Professor Howard C. Warren, of Princeton University, president of the Psychological Association, read on this occasion an extremely interesting address on "The Physical and the Mental."

President McGilvary, of Wisconsin, addressed the two associations on December 29 on "Time and the Experience of Time."

E. G. Spaulding,
Secretary

THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

The society held its ninth annual meeting at Atlanta, Ga., Wednesday, December 31, 1913, and Thursday, January 1, 1914, in affiliation with the American Association for the Advancement of Science. Fifteen of the fifty-six members were present. Three sessions were held, one on Wednesday forenoon in conjunction with Section H of the American Association for the Advancement of Science, one on Thursday forenoon, and one on Thursday afternoon in conjunction with Sections H and L. The meetings were held in the chemical lecture room of the Georgia School of Technology. On Wednesday evening the members of the society and of Sections H and L were entertained at a smoker at the University Club by Dr. H. J. Pearce, the president of the society. The president's address, entitled "The Limitations of Knowledge," was given at 4:30 on Thursday afternoon.

The following items were passed upon at the business meeting held Thursday forenoon:

1. The place of holding the next meeting was left to the council for decision. Professor Ogden invited the society to come to Knoxville, but as the American Association for the Advancement of Science will meet at Philadelphia the suggestion was made that the society meet one day at Washington and then join some of the sections at Philadelphia.

2. The following officers were elected:

President—J. B. Watson, Johns Hopkins University.

Vice-president—Josiah Morse, University of South Carolina.

Secretary-treasurer—W. C. Ruediger (re-elected), The George Washington University.

Council for three years—E. F. Buchner (re-elected), Johns Hopkins University, and L. R. Geissler, University of Georgia; for two years J. C. Barnes, Maryville College; for one year W. H. Chase, University of North Carolina.

3. The following new members were elected: Dr. Edwina Abbott, Tulane University; Mrs. A. H. Arlitt, Tulane University; Dr. F. M. Barnes, St. Louis; David June Carver, Johns Hopkins University; Edward Conradi, Florida State College for Women; Dr. Harvey W. Cox, University of Florida; Professor Ezra B. Crooks, Randolph-Macon Woman's College; Miss Lucile Dooley, Knoxville, Tenn.; James Wallace Hopkins, Tulane University; Miss Marguerite Kehr, Knoxville, Tenn.; Professor Mark Edgar Sentelle, Davidson College; Dr. E. K. Strong, Jr., Columbia University.

4. The accounts of the treasurer, which were audited for the council by Professor Ogden and approved by the society, showed a balance on hand, December 31, 1913, of $82.44. Of this $15 was allowed the secretary toward defraying his expenses incident to the Atlanta meeting.

5. The secretary was authorized to frame an amendment to Section 1, Article III., of the constitution changing the term of office for the secretary-treasurer from one year to three years.

The following papers were read by members of the society either before sessions of the society alone or before joint sessions with Sections H and L.

"New Interpretations of Psychoanalytic Data," by Tom A. Williams.

"Correlation of Physical and Mental Measurements," by J. C. Barnes.

"Dreams as Retrostructive Interprotations," by W. B. Smith.

"The Master Motive in a Theory of Knowledge," by John G. Harrison.

"Rational Psychotherapy," by Robert S. Carroll.

"Concluding from Negatives," by W. B. Smith.

"Concerning the Psychological Origin of Creation Stories," by W. T. Shepherd. (By title.)

"A Test for Adolescents," by Eleanor D. Keller.

"Avocational Education," by W. C. Ruediger.

"The Correlation of Abilities in High School Girls," by E. P. Buchner.

"Experiments with Free Association Method," by R. M. Ogden.

W. C. Ruediger,
Secretary

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A special meeting of the Anthropological Society of Washington was held at 4:30 P.M., December 9, 1913, in Room 43 of the new museum building, the president, Mr. Stetson in the chair. About fifty persons were present.

Dr. Charles B. Davenport, of the Carnegie Institution, director of the laboratory at Cold Spring Harbor, Long Island, addressed the society on "Man from the Standpoint of Modern Genetics." He said that the problem of the origin of species has now become largely reduced to the problem of the origin and survival of the characters of the species. Since groups differentiated by a single hereditary character are called biotypes, the question of the origin of species is now that of the origin of biotypes. Man is a congeries of biotypes. If these do not exist as distinct elementary species it is because of the tremendous hybridization that is taking place between biotypes. These biotypes are most nearly realized in islands, peninsulas and out-of-the-way places. The most distinct of the human races exist to-day in such places as Australia and Ceylon, the Japan Islands (Ainos), Cape Horn and inside of the Arctic circle within the old and new world. But in small islands of the coast, where people have been long settled and little disturbed, they tend to approach a pure race or biotype.

Under the shelter of this isolation, incidentally, opportunity has been afforded for an adjusted race to spring up; but there is danger of deterioration through too close interbreeding. Hybridization, as stated, is constantly preventing the complete development of these biotypes. This hybridization has gone on with man since early times so that few biotypes are now actually realized. It is now going on faster than ever and even the rare fairly pure biotypes are fast disappearing from the globe. The work of the anthropologist of the future must be largely with these hybridized biotypes; his principal study will be the inheritance of the various differential traits.

The method of inheritance of some of these traits has already been studied. Thus we know that the brown iris is dominant over its absence, as seen in blue eyes. The skin color of the negro is complex, being due to two double (or four) factors; and these may work independently of one another, so that we have one, two, three or four pigment factors in the skin, producing the typical quadroon, mulatto, Sambo and full negro skin coloration. Dark brown hair is dominant over blond hair; so that when both parents have only blond hair the children are all blonds. Two red-haired parents have only red-haired offspring. But two glossy black-haired parents may carry red hidden and so have red-haired children, as we so often see among the Irish. Kinky or curly hair is dominant over straight. Two straight-haired parents have, typically, only straight-haired children.

Many "hereditary diseases" depend on a "diathesis," a non-resistance that is clearly inherited and if matings of like or of relations occur extensively, we have the elements necessary for the production of a biotype. Among such diseases are Huntington's chorea, presenile cataract and night blindness. Other diseases are inherited as sex-linked characters—such are color blindness and the "bleeding" tendency. Very striking is the tendency to produce a real biotype of the imbecile class, because imbeciles tend to segregate themselves and to intermarry. This is the reason why we get such histories as the Nams of New York, the Hill Folk of Massachusetts, the Pineys of New Jersey and the Jukes of New York. Any condition that favors consanguineous matings, or matings of likes, favors the formation of a variety of the human race, as Dr. Alexander Graham Bell (the Francis Galton of America) long ago pointed out. Thus most institutions which do not provide permanent custodial care tend to promote such marriages; for example, among the deaf-mutes, tubercular, nervous, paupers and even alcoholics and users of narcotics. On the other hand, in consequence of social stratification fine near-biotypes, like the Lowells of Boston, the

Dwight-Woolseys of Connecticut, the Bayard-Jay-Livingston Complex of New York, and the first families of Virginia have arisen. Actors tend to marry each other and so rapidly produce nearly pure strains of histrionic talent. This nation owes more than it recognizes to its strains of inventors, surgeons, commanders, statesmen, authors, artists and financiers that have made her famous and given her the high standing she has attained in the family of nations.

Thus biotypes in man prove to be real things and their study is quite as much within the proper field of research of the anthropologist as are the commonly recognized races of men.

The paper was discussed by Dr. Hrdlička.

DANIEL FOLKMAR,
Secretary

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

AT the 223d regular meeting of the society, held January 7, Mr. August Busck gave his retiring presidential address entitled, "Notes on the Classification of the Microlepidoptera." In this address Mr. Busck reviewed the characters which have been used in classifying the Microlepidoptera, telling how the venation is now used most extensively and emphasizing this as the most important character in judging the phylogenetic relationships of superfamilies, families and genera. He presented his views on the phylogeny of the Microlepidoptera arranged graphically in a phylogenetic tree. This address, as well as some of the discussion which it called forth, will be published in an early number of the *Proceedings of the Entomological Society of Washington.*

The meeting was very well attended by members and visitors. The most distinguished visitor was the Canadian entomologist, Dr. C. Gordon Hewitt.

THE PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA, MATHEMATICAL AND SCIENTIFIC SECTION

THE fourth meeting of the year 1913–14 was held January 20, 1914.

Professor T. L. Watson and Mr. J. H. Cline presented a paper entitled "Some Examples of the Intercision Type of Stream Piracy in Western Virginia."

Professor W. A. Kepner and Mr. W. H. Taliaferro presented a paper entitled "The Organs of Special Sense of *Prorhynous*."

L. G. HOXTON,
Secretary

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN

DR. FREDERIC E. WRIGHT, petrologist of the Geophysical Laboratory of the Carnegie Institution of Washington, gave an account of "Some Phases of the Work of the Geophysical Laboratory" before the Science Club of the University of Wisconsin at its 127th meeting on December 10, 1913.

The scope of the Geophysical Laboratory of Washington is restricted to the field of experimental geology, and particularly to the quantitative investigation of the chemical, physical and physico-chemical phenomena of minerals. Artificial minerals are prepared from pure substances under known conditions, and are studied and compared with natural minerals. A great deal of preliminary work has been done by the laboratory in devising, making and standardizing apparatus.

Dr. Wright described and illustrated with color photographs projected on the screen the laboratory, its equipment and methods of work; performed experiments showing phenomena of crystallization, eutectic fusion, recalescence and other inversion phenomena; and showed by means of projected color photographs the polarization, and other, phenomena employed in the microscopic analysis of minerals. Dr. Wright exhibited a model of a fusion-equilibrium surface in trilinear coordinates representing the properties of all possible mixtures of lime, magnesia and silica, the result of six years' research in the laboratory. He also gave an account of the work of Dr. Day and Dr. Shepherd, in collecting and examining volcanic gases, and projected on the screen color photographs taken during the descent into the crater of Kilauea, showing in the most vivid way the phenomena of an active volcano at close range. The work of the expeditions to Kilauea has shown that water is present in the magma of volcanoes, at least of Kilauea; that this water is not of atmospheric origin, since no argon accompanies it; and that the heat of recombination of the dissociated gases is sufficient to keep the lava molten.

In response to a question by Dr. C. K. Leith, Dr. Wright gave a brief account of the present state of his research on the internal forces of crystals by determining the changes of form and other properties of crystals in response to change of temperature and pressure.

ERIC R. MILLER,
Secretary

SCIENCE

FRIDAY, FEBRUARY 13, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CARNEGIE INSTITUTION OF WASHINGTON[1]

IT is a source of satisfaction to record that the experience of the past year supplements that of a year ago in showing a general improvement in the relations which the institution sustains to other organizations and to the world of learning at large. The obviously rational tendency to take an objective view of the institution and its work and to measure them by the more permanent standards available is now everywhere distinctly visible. This tendency is manifested in many ways: by an increasing demand for exact information concerning the plan, scope and development of the institution as a whole; by an increasing critical interest in the investigations, the equipments and the programs of work of our departments of research; and by an increasing demand for precise knowledge concerning special apparatus and special technique developed by our departmental staffs. In addition to these numerous demands for correct information with respect to ways, means, methods and results, there are now presented also, not infrequently, requests for investigations in cooperative enterprises for which other organizations, or in some cases individuals, are willing to supply the necessary funds. This is a manifestation which, while not unanticipated, has developed somewhat earlier than expected. It calls for considerate attention, since it is likely to grow with time in proportion as the institution demonstrates capacity for trustworthy

[1] From the report of the president for the year ending October 31, 1913.

management of funds and for effective conduct of research.

On the death of Dr. Fletcher, November 8, 1912, editorial supervision of the *Index Medicus* was placed in charge of Dr. Fielding H. Garrison, who had long been associated as principal assistant with Dr. Fletcher in the publication of this work. Continuity of plan and purpose is thus assured in the perpetuation of this current bibliography, while the responsible editorship falls to one whose qualifications for the task have met the exacting standards of his eminent predecessors.

In accordance with the authorization voted by the Board of Trustees at its meeting of December 13, 1912, a department of human embryology, under the direction of Professor Franklin P. Mall, with a small staff of associates and collaborators, has been planned and is already engaged in active research. In arranging for this department the institution is peculiarly fortunate not only in enlisting the directorship of Professor Mall, but in starting from a foundation furnished by his remarkable collection of human embryos. It will be seen also that this enterprise is of far greater import than might at first appear, for it has fundamental relations to the science of anthropology as well as to those of anatomy, physiology and pathology, which latter, indeed, from some points of view, may not improperly be regarded as branches of the former widely inclusive science. The efforts of the institution to enter the domain of anthropology, to which reference is again made in a later section of this report, are thus in part realized in a most effective way.

Another noteworthy event of the year is the construction of two new buildings, a heating and lighting plant, and an additional laboratory, for the department of experimental evolution, authorized by the board of trustees at their last meeting. Plans in illustration of these buildings, which are now nearing completion, will be found in connection with the annual report of the department in the current year book. Two of the many uses which this laboratory is designed to serve in the immediate future are those of housing and further experimentation upon the unique collection of pedigreed pigeons, studied for many years by the late Professor C. O. Whitman, whose researches the institution has undertaken to complete and to publish. In accordance with the agreement entered into with Professor Whitman's heirs this unrivaled collection of biological material will become the property of the institution, and arrangements have been made for its transfer to Cold Spring Harbor from Chicago before the end of the calendar year.

Similarly, two items from the current history of the department of terrestrial magnetism are worthy of mention here. One of these is the approaching completion of an office and laboratory building whose construction was approved by the board of trustees a year ago. Floor plans of this building are incorporated in the annual report of the director of the department in the current year book. The building is situated on a very favorable, elevated site of a little less than seven acres in the District of Columbia, near Chevy Chase, and near the western boundary of Rock Creek Park. It will be fireproof, will furnish safe storage for the extensive records already acquired by the department, and will afford opportunity for experimental researches in terrestrial magnetism which may be confidently expected to give deeper insight into this obscure but at present highly utilitarian property of our planet. The other noteworthy event referred to is the near com-

pletion of a circumnavigation voyage of about three and a half years' duration and of courses aggregating upwards of 80,000 miles, by the non-magnetic ship *Carnegie*. Experience with this ship shows that a magnetic survey of the oceans is a somewhat less formidable undertaking than a magnetic survey of the continents, for the latter are still, on the whole, less accessible than the former since the advent of this non-magnetic nautical observatory. Great credit is due to Mr. W. J. Peters, commander of this ship, for assiduous attention not only to her safety, but also to the effectiveness of her mission in the immediate interests of the world's navigation and in the more important, though less obvious, interests of terrestrial physics.

Reference was made in the report of a year ago to the construction of a fireproof office building at Pasadena, California, for the staff of the solar observatory. This building has been occupied during the past year, and its characteristics are shown by illustrations in photo-perspective and in plan in the current year book. In addition to supplying adequate quarters for the departmental staff and safe storage for the extensive records of the observatory, it furnishes in its sub-basement a constant-temperature room in which will be installed a dividing engine designed especially to rule diffraction gratings for use with the other optical apparatus of the observatory. Such an engine has been constructed at the shops of the observatory during the past year by Mr. Jacomini, mechanician of the departmental staff, in collaboration with Dr. John A. Anderson, of Johns Hopkins University, who has supplied tests of precision which have led to a degree of perfection not hitherto attained in this excessively difficult and delicate kind of construction. It is gratifying to report also in this connection that the glass disk for the 100-inch telescope, which a year ago had developed distortions indicating defective stability, is now meeting all essential requirements and giving promise of an optical surface equal to, if not superior to, that of the 60-inch mirror. Accordingly, work of construction for the foundation and for the mounting of this 100-inch telescope is now proceeding as rapidly as the conditions of safety and of efficiency in such a novel undertaking will permit.

OUTLINE OF RESEARCHES OF THE YEAR

As is abundantly indicated in previous reports, and as is evident to any deliberate reader of the bewildering miscellanies presented in the year books, the diversity and the complexity of the investigations going forward under the auspices of the institution preclude anything like a clear and complete summary of their scope, progress and prospective value within the limits of an administrative report. The general reader must take it for granted (provisionally at least) that these investigations are in the main worth undertaking and thus await the verdict of time through the aid of a growing critical public opinion; for in proportion as such investigations are fundamental, and hence worth carrying on, they will be difficult of exposition and more difficult of comprehension. Concerning this matter there appears to be prevalent a popular fallacy to the effect that writers untrammeled by competent scholarship, but who possess verbal facility, are better qualified to expound a technical subject than those who have developed it or contributed thereto; and along with this fallacy there is frequently coupled another to the effect that ours is an age of narrowing specialization, whose evil effects may be remedied by resort to literary views of phenomena and by re-

stricting the range of increasing knowledge. While patiently tolerant with these extremes of opinion, it is obviously inadmissible to adopt either of them here. We may neither pretend to exposition of knowledge not acquired nor deprecate the excess of knowledge possessed by experts in this or that field of science. It is hoped, therefore, that the brief summaries given in the president's reports may not be mistaken for adequate accounts of current progress or for sufficient recognition of the merits of the researches referred to.

DEPARTMENTS OF RESEARCH

In accordance with the views just set forth it seems appropriate at this time to limit still more narrowly than hitherto the brief summaries of departmental work and to invite attention still more directly to the departmental reports published in the year book. All of the departments of research of the institution hitherto reported upon are now well-defined organizations, each of them independent of and more or less isolated from the others, and each of them devoted to a field which, while in some cases related to, does not encroach upon the fields of others. Each of them possesses thus a degree of autonomy which calls for a corresponding degree of freedom in the rendition of annual reports and accounts of progress. But along with this autonomy, indispensable to the highest efficiency in such organizations, it is equally essential that there should coexist a fraternity of interest and a solidarity of purpose centering in the institution as a whole. First steps toward development of these latter desiderata were taken in December, 1909, on the occasion of the annual meeting of the board of trustees, when the administration building was dedicated and when the directors of departments of research were invited to give exhibits of the salient features of their work up to that time. On the same occasion two related experiments were inaugurated, namely, that of a lecture to the trustees and their guests from the head of a department of research, and that of a conference between the directors of departments and the president. The results of these experiments have been so favorable that the plan of having an annual lecture, an annual conference, and exhibits of departmental work at intervals of three to five years, has come to be adopted by common consent. In addition to the exhibit held in December, 1909, another was held in December, 1911, on the occasion of the tenth anniversary of the foundation of the institution.

By reason of the decision of the board of trustees a year ago to take part in the Panama-Pacific Exposition, to begin in San Francisco in February, 1915, it is proposed to hold the next departmental exhibit in the administration building at the time of the meeting of the board of trustees in December, 1914. It will thus be practicable to bring together an aggregate from which (by aid of counsel from departmental representatives) a more restricted exhibit may be drawn for the Panama-Pacific Exposition. On account of this circumstance and on account of the fact that the departments on the average, as well as the present administration, will have completed a first decade in the institution's history a year hence, it seems desirable to reserve any more elaborate summaries of work accomplished and now under way, whether of departments or of research associates, until that time. Accordingly this section of the present report is limited to something less than the usual extent.

DEPARTMENT OF BOTANICAL RESEARCH

Studies of the Salton Sea,[2] carried on

[2] Often by earlier writers called Cahuilla Basin, more frequently called Salton Sink, and now

during the past seven years by this department in collaboration with a number of contributing specialists, have been brought together during the year in a volume now in press under the title "The Salton Sea: A Study of the Geography, the Geology, the Floristics and the Ecology of a Desert Basin," as publication No. 193. A great number of interesting questions in geography, geology, botany, chemistry, microbiology, plant physiology, climatology, etc., are discussed in this volume. Of these, an instructive abstract is given by the director in his current report.

Among many researches carried on by the director, mention may be made of his cultivation of second and third generations of mutants arising from ovarial treatments of plants and resulting in further noteworthy morphological and physiological departures from the original parent stocks. Of members of the departmental staff, Dr. Cannon has extended his fruitful studies of root systems of desert plants to include the corresponding characteristics of trees in the coastal climate of California and to the problem of treelessness in prairie regions. Dr. Forrest Shreve has given special attention to the factors involved in the transpiration of rain-forest plants and to the effects of mountain slopes and climatic conditions varying with altitudes and with exposures. Dr. Spoehr has continued his investigations of the action of light and heat in producing chemical changes in plant organisms, giving promise thus of important advances in the newer field of phytochemistry and photolysis

Several collaborators have contributed to the varied work of the department during the year. Sections of the director's report are thus devoted to accounts of the further experiments of Professor W. L. Tower on the evolution of chrysomelid beetles, for which facilities are provided at the Desert Laboratory; to the physical studies of Professor B. E. Livingston, formerly a member of the departmental staff, on the water relations of plants; to the determinations of autonomic movements in opuntias by Mrs. Shreve, whose volume on "The Daily March of Transpiration in a Desert Perennial" is in press as publication No. 194; to the investigation of Professor H. M. Richards on the acidity, the gaseous interchange and the respiration of cacti; to the surprising properties of the opuntias in fruit development, brought to light by Professor D. S. Johnson; and to the favorably progressing enterprise undertaken by the department, in collaboration with Dr. N. L. Britton and Dr. J. N. Rose, for a systematic determination of the distribution and relationships of the cactus family of plants.

called Blake Sea, in honor of Professor Blake, who, as geologist of the Williamson survey of 1853, first accurately interpreted this remarkable depression below sea-level.

DEPARTMENT OF EXPERIMENTAL EVOLUTION

The work of the year in this department records, among many other advances, additional contributions to the laws of human inheritance; the results of further and more conclusive studies of the transmission of traits in plants of the genera *Bursa* and *Œnothera;* and some preliminary indications of specially instructive investigations in the field of biochemistry. The director has divided his time between researches based on breeding experiments carried on at his station and studies of data bearing on human heredity collected under the auspices of the Eugenics Record Office, of which he is also the directing head. In addition to the researches carried on by Doctors Banta, Gortner, Harris and Shull of the resident staff, Dr. A. F. Blakeslee, Dr. G. C. Bassett and Professor John H.

Gerould have pursued investigations in collaboration with this staff. One of the most important of these cooperative enterprises is the joint investigation of Dr. Blakeslee and Dr. Gortner on the low organisms called mucors, from which it appears that sex-differentiation in these organisms has a determinate physical basis. This conclusion appears to bear a close relation to similar fundamental conclusions reached independently in other lines of work by our research associates, Dr. Reichert and Dr. Osborne.

The exigencies of his experimental work going forward at the departmental station have prevented Dr. Shull from completing the manuscript of his account of the work of Luther Burbank. It has been arranged, therefore, that he shall spend some months abroad, beginning with October, 1913, in order that uninterrupted attention to this manuscript may enable him to finish it without undue delay. The importance of the biochemical laboratory, in charge of Dr. Gortner in connection with the department, has been well attested during the year by the aid he has rendered in the complex studies evidently essential to further advances in the problems of plant and animal evolution. The more adequate provision for this laboratory adjunct furnished by the new departmental buildings, already referred to, will make it practicable to utilize still more advantageously the highly developed qualitative and quantitative methods and data of the older science of chemistry.

DEPARTMENT OF ECONOMICS AND SOCIOLOGY

Substantial progress toward completion of the several contributions from the twelve divisions of this department to their projected basis for a social and economic history of the United States is reported by Professor Henry W. Farnam, chairman of the department. It is estimated by him that six of the divisions will be able to present final reports within the next fiscal year. These are the divisions of population and immigration, in charge of Professor Willcox; mining, in charge of Mr. Parker; transportation, in charge of Professor Meyer; domestic and foreign commerce, in charge of Professor Johnson; labor movement, in charge of Professor Commons, and social legislation, in charge of the chairman. Delays due to the requirements of their primary occupations, to ill health or misfortune in the case of some collaborators, and to demands of public service in other cases, have prevented the remaining divisions from bringing their work to a similarly forward state.

The chairman again calls attention in his report to the desirability of reorganizing this department and placing it on a basis similar to that of all other departments of research of the institution. As to the appropriateness of this recommendation, there now appears to be no dissent, either within or outside the department. It is hoped, therefore, that such a reorganization may be consummated as soon as the work now in hand may be completed in accord with the original plan, if it should not appear advantageous to make the obviously desirable change at an earlier date. There is no doubt that the field of opportunity for effective pioneer work by such a department is in great need of present-day cultivation and that it extends indefinitely into the future.

THE GEOPHYSICAL LABORATORY

The preliminary stages in the development of this hitherto unique establishment may now be said to have passed, since laboratories similarly equipped and for like purposes are now being set up under other auspices. That the merits of the methods,

the apparatus and the earlier published researches of the geophysical laboratory should have been thus early recognized is at once a source of gratification to the institution and an additional stimulus to fundamental work in the difficult but ever fruitful domain of geophysics. In his annual report the director gives instructive accounts of the effects of pressure in the formation of minerals, of progress in the perfection of adequate appliances for calorimetric measures of minerals, of the factor of temperature in optical studies of crystals, of the results thus far obtained in volcano studies, and of the important economic investigations (now under way at the laboratory) of the secondary enrichment of copper sulphide ores. It had been hoped that the signal success attending the studies of Kilauea a year ago might be followed up during the past year, but in this the staff has met disappointment, for the volcano has been inactive and gives no warning of renewed opportunities.

The activities and productivities of the laboratory staff are indicated impressively by the 52 papers issued during the year, or now in press, reviewed in the report of the director. These have been, or will be, published in current journals. Several of them appear as duplicates by reason of translations into the French or the German languages; of these, it is interesting to note that a translation into French by Professor P. Chappuis has been made (for the *Journal de Physique*) of the work of Day and Sosman on "High Temperature Gas Thermometry," publication No. 157 of the Institution.

DEPARTMENT OF HISTORICAL RESEARCH

The purposes to which this department is devoted and the programs it proposes to follow have been outlined in the director's annual reports of the past seven years. He took occasion also, in December a year ago, when he gave the annual trustees' lecture, entitled "The Future Uses of History," to present a fuller statement of these purposes and programs, as well as to indicate the rôle which history may fittingly play in the evolution of the social organizations which must occupy the attention of our successors. This instructive lecture was rendered available to a wider circle of interested students of history by publication in *The History Teachers' Magazine* for February, 1913.

Briefly stated, the main purposes of the department are two: first, to furnish aids, guides and reports which may give appropriate direction to the writers of monographs and general histories; and, secondly, to furnish full textual publication of important historical documents. Under the first of these heads the director reports very favorable progress toward completion of a series of three guides to the materials for American history in London archives and in the libraries of Oxford and Cambridge universities. The first volume of this series was issued as No. 90 of the institution's publications in 1908, and the other two volumes, now nearly through the press, are designated 90A and 90B, respectively. As to this series the director remarks in effect in his report that no similar inventory of like extent, concerning archive materials which London possesses for the history of any other nation, has ever been issued. Two additional volumes in this first division of activities have appeared during the year, namely, publication No. 163, "Guide to Materials for United States History in Mexican Archives," by Herbert E. Bolton; and publication No. 172, "Guide to Materials for United States History in Canadian Archives," by David W. Parker. Under this head also progress is reported in the work of Mr. Leland on

materials for American history in Paris archives, in the work of Professor Hill in Spanish archives, and in the corresponding work of Professor Faust in Switzerland and in Austria. Under the head of textual documents the director refers in some detail to progress in the preparation of the projected collections of "Letters of Delegates to the Continental Congress," of "European Treaties Bearing on United States History," of "Proceedings and Debates of Parliament Respecting North America, 1585 to 1783," and to a preliminary report on papers of the Royal African Company in the Public Records Office of London.

Attention is especially invited to the director's interesting review of the work of the department during the first decade of its existence, completed with this fiscal year. Some idea of the extent of this work may be gained from the list of departmental publications cited, the number of these being 17, with an aggregate of over 5,000 pages; while the bulky correspondence of the institution as a whole is in some degree indicated by the fact that this department records an aggregate of upwards of 20,000 letters in its decennial inventory.

DEPARTMENT OF MARINE BIOLOGY

When the laboratory of this department was established on Loggerhead Key, Dry Tortugas, Florida, now nearly ten years ago, Fort Jefferson, on an adjacent island, was an important base station of the United States navy and transportation to and from points on the Gulf coast was a matter of daily occurrence. In the meantime, however, this station has steadily diminished in importance and is now virtually abandoned as a naval base. This change of conditions shifts the burden of transportation between the laboratory and the nearest port, Key West, about thirty miles distant, wholly upon the department; and the resulting increased cost and inconvenience have led the director to recommend a gradual transfer of his laboratory and activities to a more favorable site. Preliminary investigations indicate that such a site may be had in Jamaica, where health conditions and transportation facilities have been much improved in recent years, where the cost of labor and subsistence is low, and where such an international scope as best benefits marine biology could be readily developed. It may be anticipated that definite plans for an advantageous change of site will be matured during the coming year and ready for submission to the board of trustees in December, 1914.

The department has suffered serious loss during the year in the untimely death of a remarkably able research associate, George Harold Drew. It has met with a reverse also in the temporary illness of another research associate, Dr. T. Wayland Vaughan. Drew and Vaughan had under way important investigations, originating at Tortugas, for the furtherance of which the departmental expedition of this year to Torres Straits was largely planned and authorized. Drew had made the discovery at Tortugas that the so-called coral mud in that vicinity is not due to corals, but has been precipitated through the chemical agency of a bacillus abundant in the surface waters of the tropical Atlantic. Vaughan, on the other hand, had made quantitative studies of the growths of coral organisms at Tortugas and of the closely correlated deposits or reefs. Jointly their investigations promised a solution of the long-vexed problem of the origin of such reefs and it was hoped that the expedition to Torres Straits and Great Barrier Reef would enable them to secure the additional data essential to final proof. In spite of

these adversities, however, the director and four associates sailed from San Francisco for Sidney, Australia, on July 23, 1913, and arrived at Torres Straits early in September. When last heard from, in September, the party was reported all well on Murray Island.

The laboratory season at Tortugas extended from April to June, inclusive, and twelve collaborators availed themselves of the facilities afforded for their researches. Summaries of these are given by the director in his current report, while more elaborate accounts are furnished by the investigators themselves in appendices to that report. Two additional volumes of contributions from the Tortugas laboratory are in press as publications Nos. 182 and 183.

DEPARTMENT OF MERIDIAN ASTROMETRY

On the death, October 5, 1912, of Professor Lewis Boss, director of this department since its establishment in 1906, his son, Mr. Benjamin Boss, long associated with his father in meridian astrometry, was made acting director. Adherence to the original program, so indispensable to the formidable enterprise this department has under way, is thus assured. The extensive computations essential in the derivation of the great number of stellar positions observed at the temporary observatory at San Luis, Argentina, are going forward at a favorable rate, so that the inclusive catalogue of precise positions for stars in both hemispheres may be expected in due time. Some instructive results of these computations, showing the stability of the San Luis meridian mark (mire), the diurnal variation of the clock corrections, and the changes of personal equation for day and night observations are given in the report of the acting director.

As in most lines of fruitful research, the work of this department is noteworthy for its by-products, or for contributions it is making to allied lines of inquiry. Obviously, a first requisite to a knowledge of stellar motions lies in precise determinations of stellar positions at different epochs. The so-called proper motions of stars are thus brought to light, and from these it is possible to determine also the motion of our solar system. But now comes the surprising discovery that these proper motions, hitherto supposed to be of a random character, are of a systematic nature dependent in large degree, apparently, on the stage in evolution any individual star has reached and on the group to which it belongs. A new and peculiarly fascinating field is thus opened to astronomers of all kinds, and the by-products referred to seem destined to prove not less important than its primary object in positional astronomy. The world of astronomy, however, is anxiously awaiting the attainment of this object, as is well shown by the fact that the preliminary catalogue issued by the department three years ago is already out of print.

THE NUTRITION LABORATORY

One of the reasons which helped seven years ago to determine the location of this laboratory was found in the expectation that several hospitals would be erected in the near vicinity. This expectation has now been realized by the completion during the past year of the Peter Bent Brigham Hospital, the Collis P. Huntington Memorial Hospital, and of two hospitals for infants and children respectively. The environment and the opportunities for securing pathological subjects as well as clinical cooperation and counsel are therefore highly favorable for the researches undertaken by this establishment. That it has entered a fruitful field of activity is well attested by the wide interest shown in

its publications already issued, by the desires of experts at home and abroad to learn of the ways and means employed, and by the duplication in laboratories of other countries, as well as in those of America, of apparatus developed.

But science is cosmopolitan, and although many novel enterprises may be said to have originated with the institution, it may not lay claim to any monopoly in research; it can only contribute here and there in a limited degree to the ever-expanding aggregate of verifiable knowledge. In recognition of these limitations the director has appropriately adopted the plan of inspecting, at frequent intervals, the laboratories, the special apparatus and the technique developed elsewhere for the same and allied work. Thus he has made during the past year a third triennial tour of European laboratories, hospitals, etc., devoted to such work. This has afforded opportunity for numerous advantageous conferences with colleagues and for the selection of new apparatus of proved utility; while the director has been able during the same time to give counsel in respect to the adoption in other laboratories of apparatus and methods similar to those of the nutrition laboratory. The latter, therefore, like the geophysical laboratory, is no longer distinguished by its singularity, but must now enter upon a career of friendly rivalry with many cognate establishments.

For details of the investigations of the year, reference must be made to the director's report. They are summarized by him under thirteen principal heads, which range from studies of metabolism in infants, through those of normal metabolism in adults, up to studies of chronic starvation and diabetes mellitus. Many publications issued or in press during the year are also reviewed by the director in his report. Considerable new apparatus has been acquired and earlier forms of equipment have undergone modifications suggested by experience. Interesting mention is made of visiting and cooperating investigators, of the special researches of the laboratory staff, and of the conferences had by the director during his trip abroad. The staff has been enlarged during the year by the addition of Professor Raymond Dodge, who will undertake work in the psychology of nutrition, and by Mr. E. H. Lange, who will serve as physicist for the staff.

DEPARTMENT OF TERRESTRIAL MAGNETISM

As already indicated in an earlier section of this report, one of the noteworthy events of the year for this department will be the completion of the second cruise of the non-magnetic ship *Carnegie*. She is now on the last stretch of this cruise and may be expected to arrive at a home port before the end of the calendar year, having been continually in service since June 20, 1910. The aggregate distance traversed in her two cruises will be in round numbers 80,000 miles. The corresponding distance covered by the chartered ship *Galilee*, in the Pacific Ocean during 1905–08, is 60,000 miles. Thus the total distance traversed up to date in the magnetic survey of the oceans is 140,000 miles, or about six times the circumference of the earth. Accurate magnetic data have been obtained thereby in all of the oceans between the parallels of 50° north and 50° south latitude, or near the courses usually followed by vessels. By reason of the expedition attained in deriving from these surveys the results of chief interest to mariners, it has been practicable for chart-publishing establishments to make prompt revision of defective sailing charts or to issue corrections thereto; and a distinct improvement in these aids to navigation is already noticeable in the charts issued by the leading maritime nations. The

more complete results of these ocean surveys are also in a forward state of preparation and it is expected that a full account of the work accomplished by the *Galilee* and the *Carnegie* will be ready for publication a year hence. In the near future it is considered that the *Carnegie* should make surveys in areas not yet covered and along some stretches already traversed where cloudy or stormy conditions have prevented the securing of adequate observations. She will at the same time cross her previous tracks as often as practicable in order to determine for such intersections the information now most needed by chart-makers, namely, the annual changes in the magnetic elements.

Magnetic surveys of land areas are also proceeding at a favorable rate. An expedition under Mr. D. W. Berky, assisted by Mr. H. E. Sawyer, has traversed the Sahara Desert, starting from Algiers near the end of October, 1912, and arriving at Timbuktoo May 12, 1913; and these observers are now extending their work into the territory of west and central Africa bordering on the Atlantic. Dr. H. M. W. Edmonds has led an expedition into Canada, west of Hudson Bay, near the location of one of the supposed poles of the earth's magnetic field. Mr. A. D. Power has made noteworthy progress in a survey of northeastern South America, including a trip along the Orinoco River and the Rio Negro from the mouth of the Orinoco to Manaos on the Amazon. Mr. H. F. Johnston is engaged in a series of determinations along a line running northward from Montevideo towards Manaos. Similarly, the magnetic survey of Australia and the adjacent islands is making efficient progress under the immediate charge of Mr. E. Kidson. Under his guidance Mr. E. K. Webb was trained for and supplied with instruments for the valuable magnetic work accomplished by the Mawson Antarctic expedition.

In the near future it is anticipated that the department will have sufficient data to permit the construction of a new set of magnetic charts, including all three magnetic elements (declination, dip and intensity), especially for that part of the globe included between the parallels of 50° north and 50° south of the equator. It will then be practicable to study the general problem of the earth's magnetism by aid of a large mass of homogeneous data surpassing in definiteness any mass hitherto available for this purpose. In anticipation of the need of experimental facilities for studies of this problem and others closely related thereto the office and laboratory building of the department was authorized a year ago and is now approaching completion, as explained in a previous section of this report. For the conduct of experimental researches the department has been fortunate in securing the services of Dr. W. F. G. Swann, late of the University of Sheffield. Mr. Charles R. Duvall, late of the U. S. Coast and Geodetic Survey, has also recently joined the office staff to fill the position of chief computer.

Attention is invited to the director's remarks on the present status of the department's work, to the account of his own researches of the year, and to his programs for further work. And in the interests of further possible work of construction of buildings under the auspices of the institution, it may be worthy of note that preliminary plans for the new laboratory were well matured by Mr. Fleming, engineer of the departmental staff, before consulting an architect, and that supervision of construction has also been assigned to Mr. Fleming. This method of procedure, which has been followed in several instances by the institution, appears to be highly advantageous for economy and for efficiency.

THE SOLAR OBSERVATORY

From the date of its establishment nine years ago this observatory has been one of the most important of the enterprises fostered by the institution. It has called for heavy annual appropriations; it has grown with extraordinary rapidity and with equally extraordinary productivity; and it is now an organization whose staff of investigators, research associates and collaborators, constructors, computers, designers, mechanicians and operators includes upwards of sixty individuals. By reason of the widespread popular and technical attention given to astronomical science, and by reason of the novel equipment of this observatory and the relatively new field entered by it, the world looks with special interest on its development, quite apart from the keen general interest in the contributions it has made and may be expected to make to astrophysics. This special interest centers in the fact that the experience of the observatory furnishes the details of an experiment on a large scale in a difficult field of inquiry, for which ways and means of corresponding magnitudes have been available. In general the means at hand for such enterprises have been incommensurate with the obstacles to be overcome, and progress has been hindered, delayed or blocked until necessity has devised some indirect way of surmounting these obstacles. But, on the other hand, this necessity has hitherto exerted a highly beneficial influence in stimulating discovery and invention, and one may perhaps question whether in the past ampler means for the pursuit of systematic research would have been on the whole advantageous for the advancement of knowledge. Some eminent authorities, indeed, still question the propriety of the endowment of research in any but educational establishments. Contemplative minds are therefore awaiting the results of the experiment of the solar observatory with an eagerness only exceeded by that of the popular mind for information concerning the latest discoveries and advances in astronomical science.

In the meantime, with the installation of additional equipment and the application of appropriate methods of research, the observatory is increasingly productive. The principal results of the work of the past year are summarized by the director in his current report under seventy-two heads. No further summary of these results may be attempted here; attention may be given to a few only of the salient items of interest suggested by the report as a whole. The year has been one of minimum solar activity and noteworthy for a nearly complete absence of sun-spots. This has proved advantageous for the pursuit of studies of the sun's magnetism now definitely proved by work done at the observatory during the year. This advance in solar physics is of the highest interest by reason of its probable relations to terrestrial magnetism and to cosmic physics. Stellar and laboratory work have gone forward at a highly productive rate, and the subjects of solar, stellar and laboratory spectra and stellar velocities are among those instructively considered in the director's report. Evidence has been accumulated tending to show that light is absorbed in space, and that such a phenomenon will not only elucidate others hitherto obscure, but furnish means of measuring the greater depths of the visible universe. Professor Kapteyn has continued to act as research associate and adviser in the program of researches undertaken. The important results attained by Professor Störmer, who spent some time at the observatory as a research associate in 1912, in his investigation of solar vortices, and

those of other collaborators and members of the observatory staff, present features of special interest in the departmental report.

Favorable progress has been made in grinding the glass disk for the 100-inch telescope since the source of the obstacle encountered in this work was discovered about a year ago. The disk has been subjected to severely critical tests, which give assurances that it will meet requirements. The preparation of a 60-inch plane mirror for testing the 100-inch reflector has gone on simultaneously with work on the latter. The heavier parts of the mountings for the telescope are now under construction by the Fore River ship yards at Quincy, Massachusetts, while the foundations on Mount Wilson and the dome superstructure will probably be completed as soon as the disk and its mountings are ready. Allusion has already been made in a previous section to the new office building at Pasadena and to the remarkable success achieved in the construction of a dividing engine for ruling diffraction gratings. For adequate accounts of these and numerous other subjects of interest reference must be made to the director's full report.

WORK OF RESEARCH ASSOCIATES AND COLLABORATORS

As indicated in previous reports, the complexity of the relations which research associates and collaborators sustain to the institution is so great as to preclude any comprehensive explanation within the limits allotted to an annual administrative report. Their work embraces a wide range of subjects and varies in its conduct from individual independence to intimate collaboration with the departments of research and with the division of publications. During the past year more than twenty distinct fields of research have been cultivated and a total of more than one hundred investigators have contributed to the output. Summaries of the work of associates proceeding independently are given by them in the current year book. Their publications of the year are cited in the bibliographical lists of later sections, and the work of many collaborators is mentioned in departmental reports. Attention may be called, among many important researches, to that of Professor H. N. Morse on the osmotic pressure of solutions, now approaching completion; to the investigations of Professor Mall and colleagues in embryology; to the completion of the edition of the Arthurian Romances by Dr. H. Oskar Sommer by the publication during the year of the seventh volume of this monumental contribution to early English literature; to the appearance during the year of a translation into German of the work on "Dynamic Meteorology and Hydrography," the institution's publication No. 88, by Professor V. Bjerknes; to the significant studies of Professors Osborne and Mendel in extension of their researches on the vegetable proteids; to the fundamental investigations of Professor Reichert, brought out in publications Nos. 116 and 173; and to the penetrating contributions to philology embodied in the series of researches of Mr. William Churchill, published in Nos. 134, 154, 174 and 184.

FINANCIAL STATEMENT FOR FISCAL YEAR 1912–1913

The sources of funds available for expenditure during the past fiscal year, the allotments for the year, the revertments made during the year, and the balances unalloted and unexpended at the end of the year are shown in detail in the following statement:

Object of Appropriation	Balances Unalloted Oct. 31, 1912	Appropriation Dec. 18, 1912	Revertments Nov. 1, 1912, to Oct. 31, 1913	Total	Aggregates of Allotments and Amounts Expended and Transferred	Balances Unalloted Oct. 31, 1913
Large grants	....	$816,972	$21,287.75	$838,259.75	$838,259.75	....
Minor grants	$6,213.49	116,800	8,229.48	131,242.97	125,980.41	$5,262.56
Publications	16,881.18	60,000	5,315.33	82,196.51	66,693.30	15,503.21
Administration	....	50,000	5,000.00	55,000.00	55,000.00	....
Reserve fund	....	250,000	....	250,000.00	250,000.00	....
Insurance fund	....	25,000	....	25,000.00	25,000.00	....
Total	23,094.67	1,318,772	39,832.56	1,381,699.23	1,360,933.46	20,765.77

The following list shows the departments of investigation to which the larger grants were made by the trustees at their last annual meeting and the amounts alloted from these grants by the executive committee during the year:

Department of Botanical Research	$38,005.00
Department of Experimental Evolution	95,141.75
Geophysical Laboratory	78,000.00
Department of Historical Research	29,600.00
Department of Marine Biology	31,890.00
Department of Meridian Astrometry	25,180.00
Nutrition Laboratory	46,549.00
Division of Publications (office expenses)	9,000.00
Solar Observatory	165,631.00
Department of Terrestrial Magnetism	210,263.00
Researches in Anthropology	7,000.00
Researches in Embryology	15,000,00
	$751,259.75

The fields of investigation to which minor grants were assigned, the names of the grantees, and the amounts of the grants are shown in the following list:

Field of Investigation	Names of Grantees	Amounts of Grants
Astronomy	Kapteyn, J. C.	$2,000.00
Archeology	Bandelier, Adolf F.	2,000.00
	Van Deman, E. B.	1,800.00
Bibliography	Index Medicus	12,500.00
Biology	Riddle, Oscar	5,600.00
	Watson, John B.	500.00
Botany	Britton, N. L., and J. N. Rose	6,900.00
Chemistry	Acree, S. F.	2,000.00
	Baxter, G. P.	1,500.00
	Osborne, T. B., and L. B. Mendel	15,000.00
	Jones, H. C.	3,200.00
	Morse, H. N.	4,000.00
	Noyes, A. A.	3,000.00
	Richards, T. W.	3,000.00
	Sherman, H. C.	1,200.00
Geology	Chamberlin, T. C.	4,000.00
	Moulton, F. R.	2.000.00
History	Osgood, H. L.	1,200.00
Literature	Bergen, Henry	1,800.00
Marine Biology	Drew, G. Harold	2,000.00
	Vaughan, T. Wayland	3,300.00
Mathematics	Morley, Frank	1,200.00
Metallurgy	Howe, Henry M.	500.00
Meteorology	Bjerknes, V.	1,800.00
Nutrition	Tigerstedt, Carl	1,000.00
Paleontology	Case, E. C.	2,000.00
	Hay, O. P.	3,000.00
	Wieland, G. R.	3,000.00
Paleography	Loew, Elias A.	1,800.00
Physics	Hayford, J. F.	2,000.00
	Nichols, E. L.	3,000.00
	Barus, Carl	500.00
Physiology	Cooke, Elizabeth	1,900.00
	Reichert, E. T.	1,500.00
Zoology	Castle, W. E.	1,000.00
	Naples Zoological Station	1,000.00
Administration Building (additions)		5,792.66
Reception, National Academy of Sciences		1,000.00
International Phytogeographical Association		1,200.00
		$111,692.66

The following grants for publication were authorized during the year:

Andrews, C. M.	$2,006.22
Barus, Carl	900.00
Benedict, F. G., and E. P. Cathcart	2,200.00
Bergen, Henry	170.00
Cannon, W. A.	2,000.00
Case, E. C., S. W. Williston, and M. G. Mehl	1,200.00
Castle, W. E., and C. C. Little	2,100.00
Castle, W. E., and J. C. Phillips	650.00
Davenport, C. B.	800.00
Churchill, William, and J. P. Finley	2,000.00
Huntington, E.	3,800.00

Index of U. S. Documents relating to

Foreign Affairs	12,000.00
Jones, H. C.	1,400.00
Jones, H. C.	1,500.00
MacDowell, E. C., and W. E. Castle	600.00
MacDougal, D. T., *et al.*	4,200.00
Osgood, C. G.	9,000.00
Papers from the Tortugas Laboratory	3,800.00
Reichert, E. T.	1,094.68
Shreve, Edith B.	700.00
Smith, E. F.	4,800.00
Sommer, H. O.	6,500.00
Walcott, C. D.	272.40
Weed, L. H.	1,600.00
Wright, Albert Hazen	1,400.00
	$66,693.30

The sources and amounts of the revertments from November 1, 1912, to October 31, 1913, inclusive, are shown in the following list:

Large grants:		
Transferred from minor grants	$3,287.75	
Revertment, Division of Publications	3,000.00	
Revertment, Department of Meridian Astrometry	15,000.00	
		$21,287.75
Minor grants:		
Cooke, Elizabeth, Grant No. 878	550.00	
Drew, G. Harold, Grant No. 854	2,000.00	
Fitting, Hans, Grant No. 816	1,800.00	
Historical Research, Department of, Grant No. 794	90.00	
Osborne, T. B., Grant No. 692	83.32	
Reception, National Academy of Sciences, Grant No. 879	381.16	
Terrestrial Magnetism, Department of, Grant No. 798	25.00	
Vaughan, T. Wayland, Grant No. 855	3,300.00	
		8,229.48
Publication:		
Barus, Carl, Grant No. 872	353.50	
Benedict and Jones, Grant No. 820	284.00	
Bergen, Henry, Grant No. 826	7.13	
Burnham, S. W., Grant No. 803	884.15	
Callaway, Morgan, Jr., Grant No. 802	11.00	
Cannon, W. A., Grant No. 824	531.70	
Carnegie Institution of Washington, Grant No. 667	218.73	
Churchill, William, Grant No. 801	851.08	
Farlow, W. G., Grant No. 63	365.00	
Jones, Harry C., Grant No. 819	33.05	
Lancaster, H. C., Grant No. 814	309.70	
Loeb, Leo, Grant No. 821	323.06	
Researches of the Department of Terrestrial Magnetism, Grant No. 818	1,143.23	
		5,315.33
Administration:		
Revertment from allotted balance		5,000.00
		$39,832.56

R. S. Woodward

EDUCATIONAL INTERESTS AT WASHINGTON

I

One of my first impressions when I joined the Federal Bureau of Education at Washington, in the summer of 1906, was that of the cooperative friendliness of the various executive offices with which I had to do. Every door was open. My new-found colleagues in the Department of the Interior and its other bureaus, the higher officials of three or four other departments, with whom the business of my office soon brought me into contact, the public printer, the civil-service commissioners, the director of the census, officials of the Smithsonian Institution, the librarian of Congress, the White House staff, and the President himself—all were not only easy of access, but were prompt to welcome the newcomer and to lend him a helping hand.

On the day that I entered upon my new duties, the thermometer in my office registered 95°. The rest of the summer was steaming hot. It rained on St. Swithin's day and—more or less—for forty days thereafter, and the sticky heat was well-nigh unbearable. But the warmth of welcome which I experienced at the hands of members of the administration who were still on duty at the Capital did much to make that external heat and humidity endurable.

I began, indeed, to wonder whether the difficulties of which I had been warned were not imaginary. Here was none of that immobility of the great governmental machine of which I had heard so much. It was not until the eve of the assembling of Congress that the other side of the picture was fairly exposed. On Thanksgiving Day I was summoned before the House Committee's sub-committee on the "legislative" appropriation bill, for my first annual hearing on the estimates for the bureau for the next ensuing fiscal year. Then I knew. No great advance could be made in the usefulness of the education office without increase of appropriations; and there was evidently in Congress an intrenched tradition that the federal government should not go deeply into expenditures for public education.

In order to be quite fair, some qualifications must, of course, be made. The contrast in attitude between the executive and the legislative branch of the government was not that between white and black but that between light gray and a misty dimness.

Not everything was easy on the administrative side. There were some difficulties that were internal to the bureau. Such were, of course, inevitable. They were, however, made good in part by the loyal support of competent men and women on the staff of the office.

I may go out of my way just here to pay tribute to my venerated predecessor in the commissionership, Dr. William T. Harris. He had presided over the Bureau of Education so long, and with so dominating a personality, that in a sense it had become his own. He continued his residence in the city of Washington. He was a veritable mine of information and judgment regarding the bureau in all of its relationships. Yet from the moment that he laid down his official responsibility, he did not seek in any particular to direct or even to influence the administration of his successor, while giving at all times a friendly sympathy and support that was, to the younger man, of immeasurable value.

Secretary Ethan Allen Hitchcock was at the head of the Department of the Interior. I soon found some justification for the saying that he counted every man guilty till he should have proved himself innocent. The delicate question here was the management by the bureau of the reindeer annex to its provision for the education of the Alaskan natives. This branch of the service was in a peculiarly perplexing situation just then. When President Roosevelt had called me to Washington, to offer me the post of commissioner, his talk had hardly touched upon any other side of the bureau's activity. While the secretary's attitude on this subject for a time increased the difficulty of the situation, and a solution was not reached until he had been succeeded in the portfolio by Mr. Garfield, I entertained, nevertheless, and still retain, something like historic veneration for the really Roman personality and service of Secretary Hitchcock.

One of my earliest attempts to widen the service rendered by the education office brought me into interesting relations with an assistant secretary. He was the acting head of the department during the temporary absence of his chief. What I sought

to do was to publish a bulletin of miscellaneous educational information, to be put forth in occasional issues, as matter of practical value should become available. When I broached this plan to my associates in the bureau, one of them, having a long memory, called my attention to an obscure clause in an Act of Congress already ten years old, which expressly provided for such a publication. This was encouraging. But there was no appropriation to cover the cost of printing. As in the case of other miscellaneous printing for this office, an allotment must be secured from a general appropriation for printing in the Department of the Interior, and that was under the secretary's immediate control.

I laid the case before the acting secretary, calling his attention to the fact that the proposed publication had already been authorized by Congress, and also that it would enable the bureau to discharge more effectively one of the chief functions assigned to it in the Act for its establishment, namely, that of distributing educational information. He had himself been a member of Congress. He listened to my statement most courteously, and then replied that the thing could not be done. The money was needed for other uses.

There was, fortunately, present at the interview one of the indispensable men of the department. A fair number of such men are to be found distributed through the several branches of the government—men of sane judgment, possessed of unlimited and accurate information, devoted to the interests which their several offices serve, and free from that form of ambition which would prompt them to intrigue for their own advancement. There is no reason why I should not make individual mention of Mr. W. B. Acker, to whom I have referred. I doubt not he is still serving the public from that piled-up desk of his; and I hope the public will long enjoy and appreciate his services.

I had already consulted him with reference to my little publication plan. The acting secretary glanced toward his subordinate when pronouncing his adverse decision. Most tactfully then the under official reminded the high official that the very modest sum required could be spared without appreciable detriment to any other interest, and that the legality of such use of the fund was beyond question. With only two or three sentences, the scale was turned. The expenditure was approved, and the preparation of the first issue of the bulletin was immediately begun.

I believe the publication has been a useful one from the start, and it is now having a great development at the hands of Commissioner Claxton.

A few such experiences as that described above led me to the all-too-hasty generalization that if a public official desired to do anything new in Washington, he would either find that it is already in the law of the land, or that it is impossible—and sometimes both at once.

With other assistant secretaries, and indeed with the one referred to above, I had other relations in plenty which I can recall only with warm appreciation and gratitude.

But to come back to the legislative side of the matter. Here, again, I must avoid too sweeping a statement. In the matter of appropriations, I fared as well as my predecessors or perhaps a little better. Including the provision for the Alaska work, the appropriations were increased in those five years by about 68 per cent. This would not be so bad a showing, were it not that the total amount was pitifully small as compared with the magnitude of the interests and needs involved. For the year 1911–1912, the appropriation for the

Alaska work was $212,000, and for all of the rest of the activities of the bureau only $79,800, to which there should be added an allotment from the secretary's fund for printing amounting to $50,000.

I was early impressed with the fact that it was easier to get appropriations for the education of the natives of Alaska than for the bureau's ordinary work of collecting and diffusing information. At the first session of Congress after I had entered the bureau, through the active interest of Mr. Tawney, then chairman of the House Committee on Appropriations, there was procured an addition of $100,000 to the annual appropriation for the Alaska work. On the other hand, even small additions to the provision for collecting educational information, for the employment of competent experts in different branches of education, and so on, were secured only with the greatest difficulty.

II

It would seem, indeed, to be a fixed tradition in both Houses of Congress that the expansion of the education office shall be only gradual and comparatively insignificant. It has been shown, on the other hand, that at some time or other a rapid and considerable expansion will have to take place in order to bring up arrears, as it were, and enable the office to "start even" with its responsibilities. But that time is not yet in sight.

When one secretary of the interior made an active effort to secure increased appropriations, he was turned aside with the intimation that further legislation was necessary as a basis for such appropriations; and when this suggestion had been followed up and existing statutes had been found to cover the case completely, the session was too far advanced to secure the desired additions to the appropriation bill of that year. President Roosevelt in his last annual message recommended a substantial increase, but without result. The National Education Association passed its resolutions, and made its personal representations through a strong committee, headed by President John W. Cook, of Illinois. Some three or four years ago a wide campaign, in which the Russell Sage Foundation bore an important part, was carried on with the purpose of arousing public interest and awakening in Congress a more serious attention to the needs of the bureau. Mr. Herbert Parsons seconded this effort with an able address on the floor of the House. The result was that there was granted about one tenth of what had been sought.

There are doubtless reasons for this comparative inaction on the part of the Congress. I shall not undertake to canvass them here. But a word may be said concerning one objection frequently heard, namely, that education belongs to the states, and lies outside of the proper sphere of the federal government. It does not appear that any such objection lies against the main activity of the Bureau of Education, which is not that of educational administration at all, but that of disseminating useful information. The objection, moreover, can hardly be taken seriously as against activities which have been maintained by Congress for nearly fifty years. Each renewal of its appropriations for such activities has been a fresh assertion of the right to carry them on, and each small increase of those appropriations has laid new emphasis upon that assertion.

A comparison of the history of the Department of Agriculture with that of the Bureau of Education is instructive. Both of these offices have to do with interests which some would regard as falling within the range of the state governments, rather

than within that of the federal government. Both of them are concerned chiefly with the spread of information rather than with administrative control. Both came into being with the great advance of nationalism in the decade of the Civil War. The Department of Agriculture was established as an independent department in 1862, with a commissioner at its head, and without representation in the cabinet. After making its way against great difficulties for many years, it became a fully organized department of the government in 1889, its head becoming a member of the President's cabinet. The Bureau of Education, on the other hand, first organized as an independent department, without cabinet representation, in the year 1867, was transformed into a bureau of the Department of the Interior in 1869, and that has been its status down to the present time. The movement of congressional appropriations for these two offices is shown side by side, at ten-year intervals, in the following table:

	Department of Agriculture	Bureau of Education (Including after 1880 the Alaska Service)
1870	156,440	5,400
1880	201,000	26,995
1890	1,669,770	104,920
1900	3,726,022	116,270
1910	12,995,274	284,200

Three years later the annual appropriation for the Department of Agriculture had advanced to $22,894,590.

It may not be altogether fanciful to suggest that one reason why Congress is reluctant to enter upon any considerable increase of appropriations for the education office is a fear of the breaking loose of another avalanche of expenditure like that for the agricultural department. However, when one looks upon the great contribution which that department has made to our national prestige and prosperity, it will be seen that this is a consideration which may cut both ways.

For my own part, I have no doubt that when we get any clear vision of the meaning of science and education and the arts in our national life, we shall have liberal appropriations for these objects from the federal government; and that any interpretation of the limitations upon the federal government which would stand in the way of such appropriations, will then be regarded as fanciful and "academic."

No one can foretell how that vision will come to the American people. It is, in fact, slowly dawning at the present time. But its coming must be accelerated, or we shall have long to wait. One thing that may be expected to quicken our national insight in this regard is the growing pressure of international competition, especially in the field of commerce and industry. The opening of the Panama Canal will open the eyes of the American people in unexpected ways. Then, too, the political movement toward democracy and more democracy, as represented by direct primaries and other new forms of governmental apparatus, is making a nation-wide demand for heightened efficiency in our educational systems. Not long ago, this last-mentioned view was presented with great clearness by Senator Burnham, of New Hampshire. There are other tendencies of our time which are carrying us surely in the same direction. Our country simply can not make itself what it would be, both at home and abroad, without more of national emphasis upon the education of the whole people, and upon that advance of science and the arts on which both modern education and modern government depend.

III

In this paper I have drawn freely upon my own recollections, simply as straws in-

dicating the way the wind has blown in recent years at Washington. And I have ventured to forecast a change of weather which must sooner or later affect our national education. Sooner rather than later, I think, but I am not a prophet, to foretell the day and the hour. Now, in the space which I may still use, I should like to offer a few brief suggestions regarding the form which our new national education may be expected to take.

The question is much larger than that as to the future of the Bureau of Education. Its principal elements are those relating to a national university, to federal aid for elementary schools, to the promotion of agricultural and other technical education in secondary and higher institutions; and finally those relating to the Bureau of Education, which must, after all, have an important place of its own in the general scheme. We pass over the military and naval academies, the schools for Indians, and other special educational undertakings in which our government is engaged; and this paper must be limited to the problem, as old as our federal government itself, of a national university. Here we shall try only to get some glimpse of the bare framework of a vast design.

There is one side of our whole national life and national government which is neither economic nor political but scientific, and must be scientifically discerned. The problem of a national university is the problem of the organization of this scientific side. In some few of the states it has been measurably recognized and organized in state universities. In our federal system it has been recognized fragmentarily, and as a result various special commissions and scientific bureaus have come into existence. What is lacking is a unitary organization. And that unitary organization is requisite in order that every piece of scientific work done for the government may have back of it the whole force of established scientific method, standards, and processes, of scientific atmosphere and the ethics of science, which is realized only where many scientific departments work together long and continuously.

A special tariff commission or any other sudden and temporary scientific commission is a makeshift at the best. It will be found at length that what is needed, in place of these, is a continuous and many-sided study of wages, industrial conditions, and cost of production, the world over, carried on under conditions favorable to scientific progress, and in close connection with countless other inquiries with which these are interwoven.

We shall find, indeed, that a scientific branch of government, complete in itself, with its own traditions and its own methods, is as essential to the health of a modern nation as is a judicial branch, complete and sufficient in itself, and with its own juridical forms and procedure. It is necessary that this scientific side of our federal life be made a national entity, and given a fair opportunity of acquiring impressiveness and influence suited to its nature; and that is an opportunity of becoming a really commanding force in our national affairs in proportion to the service it is capable of rendering.

In concrete terms, this would involve a separation of those existing offices of the government which are chiefly investigational in their character from those which are chiefly administrative; the grouping together of those of the former class, under some convenient working system; and the organization of new divisions, somewhat similar in character to the scientific bureaus already in existence, in order to deal with new needs as these shall become apparent and urgent. The process may very likely

be a slow one; but it is a building for the centuries, and the movement toward a comprehensible end is the principal thing at the present time.

Among the offices and institutions to be brought together in this unique university would naturally be the Library of Congress, the permanent organization of the Census Office, the Geological Survey, the Bureau of Standards, the Naval Observatory, and possibly the more strictly scientific offices of the Department of Agriculture. The Bureau of Education should be included, so far as its typical activities are concerned, provision being made elsewhere for the discharge of its administrative functions. It does not appear that the special form of organization of the Smithsonian Institution would prevent it from being made a member of this central group, in which its membership, with that of the National Museum, would be of the utmost importance. If not incorporated in the new organization, it should at least be related to it through some close affiliation.

A very fair beginning might be made with such a group. It should be reasonably clear that a university so constituted at the outset would be different from any that the world has hitherto seen. It would indeed be an institution of national dimensions, as well as of national functions.

It is not to be supposed that the mere putting together on paper of these great government offices would make such a national university as is here proposed. The federal legislation which should bring them into one interlocking group would be but the bare beginning. The adjustment of their mutual relationships, the rounding out of the organization by the addition of needed departments and activities, the settlement of the relations of the university to other branches of the federal government and to educational systems and institutions throughout the country—all of these things will call for imagination and foresight and administrative ability of the highest order. Under the authority and with the support of the Congress of the United States, the offices and governing boards of the new institution will have the responsibility of shaping a real organ of enlightenment, which shall not only be for all of the sciences and for all of the people, but shall be an effective working instrument as a whole and in its several divisions.

The relations of such a national university to other scientific foundations and institutions of learning, at home and abroad, will be of the utmost consequence. So far as American universities are concerned, its relations with them may have something of the "federal" character. It will not supplant them; it will not merely supplement them; to some extent, I think, it will have its existence in them, and they will be participants in its life.

As I conceive it, the national university will be a teaching body as well as an investigating body, but it will not confer any academic degrees. As a teaching body, it will escape the reproach of abstractness and lack of system which lies against some laboratories and bureaus of pure research. Its teaching courses, which must necessarily be of an advanced grade only, may be brought into very fruitful relations with a reorganized office for the federal civil service. On the other hand, to withhold from it the power to confer the traditional degrees, will be to emphasize its unique character, and in the end will add to its strength and influence. Let universities such as we now have, continue to celebrate their commencement occasions and bestow their beribboned diplomas, undisturbed by any federal competition. These things are not unimportant, but the institution that is here proposed will have other and rather

more weighty business. Nevertheless, it is inevitable that if its work be well done it will eventually become the foremost factor in determining the standard and the standing of American scholarship and American degrees before the nations of the world, and consequently before our own people here at home.

The investigation of a network of problems of labor, the costs of production, customs duties, commercial relations, and the regulation of corporations, will be one of the earliest undertakings which a national university may be expected to place upon a scientific basis. Its studies in this field will of necessity extend over decades and even generations. But within a few years there should be assembled and made available for use a greater body of digested information on these subjects than any Congress or administration in this country or any parliament or ministry abroad has ever had, on which to base its industrial legislation.

To amass information, however, is not of itself scientific. What is to be chiefly hoped is that from such researches, in which closely related sciences shall be cultivated together and all upon the largest scale, there shall emerge new and enlightening theories, embodied in new and well-grounded principles of social development.

Finally, if I have spoken thus far of the sciences only, it is not meant to the exclusion of the arts. Quite the contrary. In a more profound sense than is commonly believed, the arts are bound up with the sciences in the making of our civilization. Music, sculpture, and painting are, generally speaking, mere hangers-on in our scheme of higher education to-day. This is one of the defects in our university life which the nineteenth century has handed on to the twentieth. It is one of the defects which a national university should help us to correct. If we are to have anything like national standards in our drama, in our fiction and our verse, in the aggregate architecture of our cities, in the fine arts generally—still more, if we are to make a disciplined sense of beauty sustain, correct, and supplement the scientific trend of our life—our national university must help us in this great work. At best, it is a slow work and a mighty. We shall do well if another century shall find us far advanced upon it.

What has been offered here is only the barest outline of a great hope and dream for our national life. It will seem far removed from those briefly jotted experiences with which this article began. It is a hope and dream which those experiences, however petty by comparison, did not in any measure dampen or abate. Indeed, while I had at Washington a keen sense of the disproportion between the work in which I was engaged and the work of that kind which this country imperatively needs, I went on in that work with a growing conviction that no greater or lesser perfomance of my own or of any other commissioner, no favoring or adverse attitude of successive secretaries, congresses, or presidents, can in the long run prevent this country from erecting its great national institution of education, science, and the arts, at least coordinate with the traditional branches of government, in which all systems and institutions of science, art, and education throughout the land shall be participants, and shall find therein a new realization of their best ideals.

Elmer Ellsworth Brown
New York University

LOCAL BRANCHES OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

At the Atlanta meeting of the American Association for the Advancement of Science the following resolutions were unanimously adopted:

Resolved, That the council of the American Association for the Advancement of Science authorizes the establishment of local branches of the association in places where the members are prepared to conduct branches which will forward the objects of the association.

Resolved, That the standing committee on organization and membership be instructed to promote the establishment of such local branches.

The plan of regional division and local branches has been under consideration for some time. Last year a Pacific Coast division was established and an associate secretary for the south was appointed. At the Atlanta meeting a Brazilian division was authorized. There is every reason to believe that a forward step in the advancement and diffusion of science can be taken by the establishment of local branches, especially in places where there are no chapters of the Society of the Sigma Xi, academies of science, or similar organizations. Even where such agencies already exist, a union of the members of the American Association might cooperate with them for their common interests. A local branch can arrange for lectures, scientific programs, dinners and social meetings, which will bring together those interested in the progress of science, will encourage them in their work and improve the conditions under which it is done, and will increase the interest of the community in science. If a number of local branches are formed in a state or a region it will be possible to arrange for joint meetings or for a lecturer to address meetings in the different places.

The great increase in the number of scientific men, their scattering in this country over a vast area and the differentiation of their work have made it difficult or impossible for them to come together at national meetings and discuss their common objects. The advance and necessary specialization of science tend to divorce it from the interests of the people on whom in a democracy it must depend for recruits and for support. Local societies or clubs, especially in smaller centers where there are not enough scientific men to form groups of specialists and where lectures and scientific programs are not common, can accomplish a great deal to maintain interest in research and to impress its importance on the general public. They will be aided by the prestige of the history and the national scope of the American Association with its eight thousand members and will in turn strengthen the work and influence of the association.

The standing committee of the association on organization and membership, of which Dr. W. H. Welch, of the Johns Hopkins University is chairman, the permanent secretary, Dr. L. O. Howard, is a member, and Professor J. McK. Cattell, Garrison-on-Hudson, N. Y., is secretary, has been authorized to promote the formation of such local branches and the secretary of the committee will be glad to correspond with members of the association who may be interested in the formation of local branches which will promote the objects of the association in their neighborhoods.

SCIENTIFIC NOTES AND NEWS

The Senate has confirmed the nomination of Col. William C. Gorgas as surgeon-general of the United States Army.

Dr. Walter P. Bradley has resigned as professor of chemistry after twenty-five years of service at Wesleyan University to take charge of the investigations of the United States Rubber Company in whose employ he recently spent a year's leave of absence.

Dr. Edwin G. Conklin, professor of biology in Princeton University, has been elected a foreign member of the Royal Bohemian Academy of Sciences.

Dr. Samuel Amberg, of The Otho S. A. Sprague Memorial Institute Laboratory, of Chicago, has been elected a corresponding member of the Society of Internal Medicine and Pediatrics in Vienna.

Dr. Adolf Frank, known for his important contributions to agricultural chemistry, celebrated at Charlottenburg, on January 20, his eightieth birthday.

Professor W. M. Davis, of Harvard University, plans to carry out an exploration of some of the coral islands in the Pacific. He is so arranging his tour as to be able to attend the

meetings of the British Association in Australia.

Professor E. W. Brown, of Yale University, has accepted the invitation of the British Association for the Advancement of Science to attend the Australia meeting in 1914. He expects to be absent from the university until February, 1915.

Dr. J. C. Arthur and Mr. F. D. Fromme, of Purdue University, are making a botanical trip through Texas, New Mexico and Arizona during the month of February. The special object of the trip is to obtain additional information on certain species of Uredinales, whose life histories are incompletely known.

Professor George B. Rigg, of the University of Washington, is absent on leave for the rest of the academic year. He is at the University of Chicago.

Walter Wallace Weir has been placed in charge of cooperative drainage experiments being carried on at Kearney Park, near Fresno, on the 5,400-acre ranch belonging to the University of California. The University and the Office of Experiment Stations of the United States Department of Agriculture are making these investigations in the reclamation of alkali lands by drainage ditches and a pumping system.

We learn from *Nature* that Mr. J. I. Craig has been transferred from the directorship of the meteorological section of the Egyptian Survey Department to the controllership of the Department of Statistics, and has been succeeded at the survey by Mr. H. E. Hurst.

Mr. W. Lawrence Balls, botanist to the Egyptian government, Department of Agriculture, has left the service and is returning to Cambridge to work up the data on cotton which he has collected.

Dr. Emil Abderhalden, professor of physiology at the University of Halle, will lecture at Columbia University next autumn.

Professor Dana Durand, of the University of Minnesota, formerly director of the United States Census, will lecture at Harvard University in April on combinations and trusts.

Professor D. W. Johnson, of Columbia University, recently gave an illustrated lecture before a joint meeting of the American Scenic and Historic Preservation Society and the American Museum of Natural History on the subject "The Scenery of the Atlantic Coast and Its Answer to the Question: Is the Coast Sinking?"

Professor Waldo H. Norris, of Grinnell College, will lecture on zoology at Harvard University this term under the exchange agreement with colleges of the middle west.

Dr. W. P. Mason, professor of chemistry in the Rensselaer Polytechnic Institute, lectured on January 29, before the Franklin Institute of Philadelphia, on advantages and disadvantages of water storage.

Dr. John P. Stewart, professor of experimental pomology of the Pennsylvania State College, during the current fall and winter has lectured before the Maine State Pomological Society, the Massachusetts Fruit Growers' Association and the New Hampshire State Agricultural Convention on "The Results of Seven Years' Experiments with Different Cultural Methods, Covercrops and Fertilization in Apple Orchards."

Dr. W. B. Scott, Blair professor of geology and paleontology at Princeton University, is giving a course of six lectures on the theory of evolution before the Wagner Free Institute of Science, Philadelphia. The lectures which are given on Saturday evenings are on the Richard B. Westbrook Free Lectureship.

Dr. Dayton C. Miller, professor of physics in the Case School of Applied Science, has delivered before the Lowell Institute, Boston, a series of eight lectures, the subjects of which were as follows: January 20, Sound, Sound Waves, Character of Sounds; January 23, Pitch, Loudness, Tone Color, Pure Tones; January 27, Methods of Recording and Photographing Sound; January 30, Effects of Horn and Diaphragm on Sound; February 6, Tone Qualities of Various Musical Instruments, Ideal Tone; February 10, Physical Characteristics of Vowels and Other Sounds of Speech; February 13, Synthetic Reproduction of the

Tones of Instruments, of Vowels and Spoken Words.

AT the College of Medicine of the University of Illinois, Chicago, Drs. Bartlett, Burmeister, Davis, Dreyer, Eycleshymer, Falls, Fantus, Hartung, Miller, Moore and Welker recently organized a medical research club of the University of Illinois. Dr. D. J. Davis was elected president, and Dr. Wm. H. Welker was elected secretary for the balance of the college year. Dr. Eycleshymer presented a paper entitled, "Some Observations on the Decapitated Young *Necturus*."

THE *British Medical Journal* understands that arrangements have nearly been completed for the establishment, as a memorial to Lord Lister in Edinburgh, of a Lister Institute. It is proposed that the institute, which will be devoted mainly to research in bacteriology and pathology, shall work in connection with the university, but that it shall be managed by an independent board consisting of representatives of the Royal Colleges of Physicians and Surgeons, and of the university, and probably of the Carnegie trustees, who have recently become interested in the laboratories of the Royal College of Physicians. It is intended that certain facilities for teaching shall also be provided. It would appear to be the intention that eventually all pathological work, both in research and teaching, in Edinburgh shall be under the general supervision of the professor of pathology, who, in addition to holding that chair and taking an appropriate share in the conduct of the new institute, will act as honorary pathologist to the Royal Infirmary.

DR. WILLIAM KELLY SIMPSON, professor of laryngology at the College of Physicians and Surgeons, Columbia University, died on February 6, aged fifty-eight years.

DR. K. H. F. ROSENBUSCH, formerly head of the geological-mineralogical laboratory at Heidelberg, distinguished for his contributions to mineralogy, has died at the age of seventy-eight years.

DR. FELIX HAHNSCHAFFE, professor of geology in the Berlin Mining Academy, has died at the age of fifty-three years.

THE U. S. Civil Service Commission announces an open competitive examination for assistant chief, Bureau of Chemistry, to fill a vacancy in this position in the bureau of chemistry, Department of Agriculture, at $4,000 a year. It is desired to secure the services of a man of broad training and extensive practical experience in physiological chemistry and medicine as well as experience as an administrative officer to assist in the research and supervisory work of the bureau of chemistry, and the enforcement of the food and drugs act. Applicants will not be assembled for examination, but their relative qualifications will be rated upon the evidence adduced as to their education and training, practical experience and fitness, and their publications. Applicants must give in their applications a complete statement of their educational training, a complete statement of their practical experience, and a list of their publications. Copies of such publications should be filed with the application. An educational training including an M.D. degree from a medical school of recognized standing and special training in analytical and physiological chemistry other than that included in the medical course; and not less than three years' experience as a medico-legal expert, and some experience as an administrative officer, are prerequisites for consideration for this position. Applicants must have reached their thirtieth but not their forty-fifth birthday on the date of the examination.

UNIVERSITY AND EDUCATIONAL NEWS

BOWDOIN COLLEGE has received a bequest of $500,000 for the general fund of the college from the estate of Edwin B. Smith, former assistant attorney general of the United States, who died in New York on January 5.

YALE UNIVERSITY receives $500,000 under the will of Lord Strathcona and Mount Royal, who died on January 21. The Royal Victoria College at Montreal, a girls' school, is given $1,000,000. Lord Strathcona leaves to St. John's College, Cambridge, $50,000; to the University of Aberdeen, for the creation of a chair of agriculture, $25,000; to the Presby-

terian College at Montreal, $60,000, and to Queen's University, Kingston, Canada, $100,000. In addition to this sum he bequeathed to the Royal Victoria Hospital at Montreal $500,000, and to hospitals in the British Isles, $90,000. The bequest to Yale University is

for the promotion of the modern sciences, and for instruction in the practical questions arising from the application of scientific knowledge to the industrial, social and economical problems of the times, it being my special desire to have the said sum expended so far as in the opinion of my trustees may be deemed advisable for instruction in civil and mechanical engineering, with special reference to the construction, equipment and operation of transportation of passengers and freight, whether by land or water, and the financial and legislative questions involved.

Through the will of the late Mrs. Elizabeth Mattox, of Terre Haute, the sum of $45,000 will be added to the general endowment of De Pauw University.

Mrs. William Porter Herrick, widow of the late William Porter Herrick, has given to the University of Colorado, $5,000, to be used as an aid fund for worthy students.

Sir Hildred Carlile, M. P., has given $500,000 to Bedford College, London, as a memorial to his mother, Mrs. Edward Carlile.

Dr. Hugo Frommsdorff, on the occasion of the fiftieth anniversary of his doctorate, has given $5,000 to the University of Heidelberg for a foundation for the advancement of chemistry.

According to the daily press President Edmund J. James, of the University of Illinois, called, on February 3, a meeting of the faculty and announced that he had received reports that he did not possess the confidence and support of the faculty without which he did not wish to retain the presidency. The faculty in secret ballot by a vote of 188 to 4 declared confidence in President James.

It is announced that Dr. Frank J. Goodnow, Eaton professor of administrative law and municipal science at Columbia University, at present constitutional adviser of the Chinese Republic in Peking, has been offered the presidency of the Johns Hopkins University.

Dr. M. A. Brannon, professor of biology in the University of North Dakota and dean of the college of liberal arts, has been elected president of the University of Idaho.

DISCUSSION AND CORRESPONDENCE

LABELLING MICROSCOPIC SLIDES

Within the last year or so Science has published four short articles on labelling slides.[1] From this it would seem to be a subject of some interest. I have therefore ventured to add a method which I have been using with entire satisfaction for some time past.

The objections to scratching slides or other glassware with a diamond or carborundum is that the label can not be removed, if for any reason this is necessary. Another objection that is equally serious is the difficulty of making clear and legible labels where several words must be written. These reasons led me to abandon this method long ago.

Marking with wax pencils is of doubtful value owing to the extreme care necessary to avoid removing the label through contact with xylol or by mere rubbing. My own experience with waterproof ink has been that it is also too easily rubbed off or washed off while passing slides through water or aqueous stains.

Etching or grinding the surface of the slide is satisfactory where the surface thus prepared is to be used frequently but is entirely too troublesome for ordinary slides. Moreover, the pencil label is not always easily legible.

I now use an ordinary india ink (l'encre de chine) to which I have added a little ordinary water glass (sodium silicate solution) such as is sold at the corner drug store for preserving eggs. It is usually better to thin, after adding the water glass, with enough water to make the ink flow freely. With this ink one can write with a fine pointed pen any label that he

[1] A. F. Blakeslee, "A Labelling Surface for Glassware," Science, 37: 561, 1913; Zae Northrup, "A New Method for Labelling Microscopic Slides," Science, 38: 126, 1913; Ernest Shaw Reynolds, "Labelling Microscopic Slides," Science, 38: 363, 1913; Frank E. Blaisdell, "Labelling Microscopic Slides," Science, 38: 665, 1913.

would have been able to write on paper. It can be put on the slide as soon as the paraffin ribbon has been mounted. If the slide was clean when the label was written, water, alcohol and xylol may be applied to it freely without any danger of injury. Ordinary abrasion such as the slide frequently encounters in use will not in any wise affect the permanency of these labels. They can, however, be scratched off easily with a dull knife (or scrubbed off with scouring soap). A white paper label pasted on the *back* of the slide will make it even more conspicuous.

LANCE BURLINGAME

STANFORD UNIVERSITY, CALIFORNIA,
January 14, 1914

A NEW NAME FOR THE MARMOT OF THE CANADIAN ROCKIES

MR. ARTHUR H. HOWELL has called my attention to the fact that the name applied by me to the large marmot from the Moose Pass branch of the Smoky River, Alberta, *Marmota sibila*,[1] is preoccupied by *Arctomys sibila* Wolf.[2] The marmot of the Moose Pass region may be called *Marmota oxytona*.

N. HOLLISTER

U. S. NATIONAL MUSEUM,
November 5, 1913

SCIENTIFIC BOOKS

Mathematical Monographs. Edited by MANSFIELD MERRIMAN and ROBERT S. WOODWARD. No. 12. *The Theory of Relativity.* By ROBERT D. CARMICHAEL. New York, John Wiley & Sons. 1913. Pp. 74.

Unlike most presentations of the theory of relativity, which contain a considerable amount of technical mathematical physics, Carmichael's is non-technical and logical in the same way that the discussion of the foundation principles of geometry or mechanics or chemistry might be made non-technical and logical. The book may, therefore, be read with ease by the mathematician who has little or no knowledge of modern physics or by the physicist who is unacquainted with mathematical analysis; it might be read by the engineer or, for the most part, by the philosopher. The work is in no sense a mere compilation from the investigations of previous authors, but represents a considerable amount of independent investigation of which the major part has appeared in contributions to the *Physical Review*.

The strongest and most satisfactory part of the book is that dealing with the statement of the postulates upon which the theory is built and with the direct consequences of the postulates. Less final and satisfactory are those parts where the physical theories (as distinguished from the results of physical experiments) which might conceivably underlie the theory are mentioned. This lack of finality and satisfaction is, however, quite unavoidable in these latter days when so many phenomena apparently subversive of long-accepted notions are constantly being unveiled. One has only to read the report on "La Théorie du Rayonnement et les Quanta,"[1] of the colloquium held at Brussels in 1911 to see in what a state of partial bewilderment and contradiction are the leading physicists of our time. The riot of new hypothesis and theory in the last volume (No. 26) of the *Philosophical Magazine* is a similar indication.

The author abstains from electromagnetic theory and confines his attention to the relation of the theory of relativity to the concepts of length and time, of mass and energy; he has, however, to mention that fundamental unit of electricity, the electron. He does well to emphasize the independence of the theory of any hypothesis as to the existence or non-existence of the ether, even though he subsequently finds it useful to make use of the ether in discussing the physical nature of mass. He could profitably have gone a little more into detail with regard to the relation between the ether and relativity.

Once we admit the existence of a stagnant ether, we have at hand at least a logical fixed system of reference; we may logically speak of

[1] Smithsonian Miscellaneous Collections, Vol. 56, No. 35, p. 1, February 7, 1912.

[2] Linne's "Natursystem," Vol. 2, p. 481, 1808.

[1] Langevin and Broglie, Gauthier-Villars, 1912.

absolute motion, even though we may be unable experimentally to determine the absolute motion; the change of mass and of length which arise in moving systems are then but the natural consequences of the redistribution of the lines of force issuing from the moving charges; our concept of time and distance is no longer in need of modification; we have essentially the original Lorentz point of view. The theory of relativity then is merely a collection of results interpreted on moving axes (with local time) and abstracted from the underlying ether; the fundamental postulate M of the theory, that we can not detect absolute motion, is a natural consequence of the fact that the transformations between different sets of moving axes (and times) form a group. For instance, if two particles move in different directions through the ether each is actually shortened in the direction of motion, but observers attached to the particles can observe no shortening because everything in the system is similarly shortened. And moreover, since the transformations above mentioned form a group, each observer, abstracting from any conception of the ether and experimentally unaware of any shortening in his system, concludes that the system of the other observer is shortened in the direction of their relative motion and by the amount appropriate thereto.

On the other hand, if we take the point of view that what we can not directly observe does not exist, if we take the theory of relativity as itself fundamental and banish the ether, then we have no such physical or conceptual basis upon which to explain the shortening, the alterations in mass, or the changes in time, and we are forced to change our concepts of mass, length and time; we are forced to all those new ideas which the theory of relativity brings in and which seem incongruous or bizarre to many persons, and these ideas assume a semblance of naturalness only when our universe is interpreted as four-dimensional with space and time unified and inherently interrelated, in the manner adopted by Minkowski or Wilson and Lewis or McLaren. Which of the two points of view we adopt depends largely upon our turn of mind. There are philosophers who feel that we are entirely free to construct for ourselves any image of the physical universe which seems most natural and easy; they will probably hold to the ether as long as possible. There are others who feel that we should not intrude into the image any ideas which represent things not immediately subject to experiment; they will declare for the principle of relativity as fundamental and not as derived, just as Walther Ritz declared against electric and magnetic field-intensities E and H.

The author knows all this and covers most of it in different parts of his work, but seems nowhere to collect it. The brief discussion of the mass of light is too indefinite to convey any useful impression to me. The attempt at the end of the work to outline a further experiment bearing on the theory is laudable in itself and shows that the author has thought deeply into his subject from other sides than the logical.

Edwin Bidwell Wilson
Massachusetts Institute of Technology

Osmotic Pressure. By Alexander Findlay. Longmans, Green and Co., New York. Cloth, 8vo. Pp. 84. Price $1.00.

This book by Dr. Findlay is one of the series of monographs on inorganic and physical chemistry of which he is the editor. The purpose of these monographs is "to place before advanced students of chemistry, accounts of certain sections of inorganic and physical chemistry fuller and more extended in scope than can be obtained in ordinary text-books." The present monograph deals with semi-permeable membranes and osmotic pressure, 6 pages; van't Hoff's theory of dilute solutions, 4 pages; direct determination of osmotic pressure of concentrated solutions, 12 pages; discussion of the recent determinations of osmotic pressure and of the van't Hoff theory, 4 pages; the general theory of ideal solutions, 10 pages; discussion of the osmotic pressure of aqueous solutions of cane sugar in the light of the theory of ideal solutions, 13 pages; indirect determinations of the osmotic pressure, 15 pages; views regarding the cause of osmosis

and the action of the semi-permeable membrane, 12 pages. Three pages are devoted to references. Two figures appear in the text. The treatment does not claim to be exhaustive "so far as concerns work important in its time but now only of historical interest," the aim being to give special attention to recent investigations.

The amount of space devoted to thermodynamical considerations and the so-called theory of "ideal" solutions, together with the mode of treatment and what one reads between the lines, clearly shows the author's leanings. It is, however, quite safe to say that those who have actually spent their time in the laboratory at practical work with innumerable solutions and diverse osmotic membranes, entertain very little hope of a better understanding of solutions and osmosis from thermodynamical computations and mathematical equations of what are termed "ideal solutions." One might indeed about as well talk of an ideal chemical compound, an ideal plant, or an ideal animal, as of an ideal solution.

The monograph will doubtless prove useful to students of the subject of osmosis, especially because of the references to the recent literature, even though these be incomplete. It moreover also contains a good, clear exposition of the existing physical theories of osmosis and solutions. But in a publication of this kind, which is especially intended for students, one has a right to expect something that will inspire and spur the student on to further experimental inquiry in the subject. In this respect, however, the monograph is sadly lacking, and how can it be otherwise, for to those that seek to solve the problem by thermodynamics and theories of "ideal solutions" new experiments along specific lines naturally do not suggest themselves, for they are really not required for the purpose of the explanation. A theory of "ideal solutions" suggests chiefly how known facts can be harmonized with it and how the "troublesome exceptions" may be accounted for; it does not suggest how new fields may be opened up. To those that thus vainly hope to solve the practical problems of solutions and osmosis particularly as they relate to organic beings, one may well quote the immortal words of Goethe, "Grau teurer Freund ist alle Theorie und grün des Lebens goldener Baum."

LOUIS KAHLENBERG

THE BOTANICAL SOCIETY OF AMERICA

THE eighth annual meeting of the Botanical Society of America was held in the State Capitol Building, at Atlanta, Georgia, December 30, 1913, to January 1, 1914, about ninety members being present. The following officers were elected:

President—A. S. Hitchcock, U. S. Department of Agriculture.

Vice-president—B. M. Duggar, Missouri Botanical Garden.

Councilor—D. G. Fairchild, U. S. Department of Agriculture.

One hundred and thirty new members were elected to the society.

The report from the committee on the new journal was adopted. This provides for a co-operative arrangement with the Brooklyn Botanic Garden which will make possible the immediate publication of the journal and the first number of the *American Journal of Botany* will appear during January. All members of the society become contributing subscribers to the *Journal*, the price being fixed at \$3.00 annually to members and \$4.00 to non-members. Attention is called to the fact that candidates for membership (meaning those whose applications were received too late for action or those who may apply for membership during the year) may, upon approval of the council, receive the journal at the same rate as members.

The address of retiring President L. R. Jones on "Problems and Progress in Plant Pathology," together with the symposium on "Temperature Effects," participated in by Dr. Frederick Barry, Dr. B. M. Duggar, Dr. D. T. MacDougal and Dr. Forrest Shreve, will probably be published in the new journal of the society.

The dinner for all botanists was held New Year's night, the topic for discussion being the new journal.

Following are abstracts of the papers presented at the general sessions and at the newly organized physiological section:

The Seasonal Life History of Some Red Algæ: I. F. LEWIS.

Experiments were performed at Woods Hole dur-

ing 1911, 1912 and 1913 on the following species: *Griffithsia Bornetiana*, *Dasya elegans* and *Polysiphonia violacea*. Tetraspores and carpospores were planted on oyster shells, which were then fastened to piles and left during the winter. The annual life cycle of the species studied runs as follows:

In June young plants become visible. These produce, for the most part, tetraspores, though an occasional sexual plant may be found. The tetraspores are released in July and germinate immediately to form the second crop, which consists of sexual individuals. These often occur on other algæ and *Zostera*, whereas the first crop of tetrasporic individuals is confined to stones, piles and other objects of a more or less permanent nature. The sexual crop releases its carpospores in August or early September. It is the small sporelings from these spores which winter over. The individuals which have attained any considerable size all die at the approach of cold weather. The tiny holdfasts of the very young sporelings may be seen during the winter and spring. From them arise the tetrasporic plants of the first summer generation.

The alternation of generations in these species is thus connected with their seasonal occurrence. The sexual generation is characteristic of late summer, while the tetrasporic plants survive the winter and predominate in early summer.

There is no sharp line between the first and second crops, as a small percentage of both occur out of season. This is particularly true of the tetrasporic individuals, which under favorable conditions may survive throughout the summer and continue to produce spores up to September. A few of these belated tetraspores form holdfasts which winter over and produce the scarce sexual plants of the early summer following. In general, however, the two crops are well marked.

The Marine Algæ of Peru: MARSHALL A. HOWE.

The specimens on which, chiefly, the paper was based were secured by Dr. Robert E. Coker, now of the U. S. Bureau of Fisheries, while acting as fishery expert for the government of Peru during the years 1907 and 1908. They are referable to about 100 species and they constitute one of the largest collections of algæ thus far made in South America and by far the best ever brought from Peru. For the satisfactory determination of the specimens it has been necessary to examine the original materials of a considerable number of little-known and briefly described South American species. The algæ of Peru has been sparingly collected, especially during a period of seventy-five years preceding Dr. Coker's visit, and about one third of the species found by Dr. Coker appear to be undescribed. Although Peru lies wholly within the tropics, its marine flora, with the exception of a strip of coast about twenty miles long at the extreme north, is of a temperate rather than a tropical character. This is apparently due to the influence of the Humboldt or Peruvian Current, which brings northward the cold waters of the South Temperate and Antarctic regions. The mean summer temperature of the ocean at Callao, latitude 12° South, is said to correspond to that of New York, latitude 41° N., and of Monterey, California, latitude 36° N. Accordingly, one finds the typically tropical genera of green and red algæ poorly or not at all represented on the coast of Peru. Instead, the larger brown algæ, species of *Macrocystis*, *Lessonia* and *Eisenia*, are the dominating elements in the marine flora.

Lantern photographs were exhibited, showing some of the more characteristic species of the region. Among these were several illustrating the hapteres and the disposition of the sporangia in various forms of *Macrocystis*.

The Trend and Influence of Certain Phases of Taxonomy: AVEN NELSON.

Taxonomy has its place. It trains the perceptive faculties, teaches orderliness, develops judgment and strengthens reason. There is a saving grace in botany not found in most of the other sciences and this is exercised through taxonomy more fully than through all the other divisions of botany combined.

Systematic botany furnishes to the average layman a more continuous incentive for pleasurable and inspiring contact with the world about him than any other subject that lays claim to a place in a cultural course. It may be the primitive phase, but most great botanists at least began at this point, thus illustrating in their development the recapitulation theory.

Systematists were never so numerous nor more active than at present. All activity is not necessarily progress. Motion up and down may be spectacular and nothing more.

There is but one reason for the existence of the professional systematist; viz., to make it easier for others to know plants. If we fail in this one thing we fail in all. Judging by the indifference of the multitude to our work; by the hopelessness of the amateur who tries to acquaint himself with

the plants he meets; by the none-too-well concealed cynicism of our colleagues in other lines, we are failing in this. Our work has been analytic, not constructive. We have dismembered organisms and held up to view their component parts. We have been looking for differences, and with such amazing success that the fundamental resemblances have, for the most part, escaped our notice.

Morphology, physiology, ecology and economic botany in its scores of applications have all gone forward by leaps and bounds, but in spite of, not by the aid of, taxonomy. Not all taxonomic work has been useless or erroneous. Keenness of observation and great powers of discrimination are not lacking. It is not so much that what has been should not have been done, but rather that more should have been done to relate recent work to that which has gone before. Synthesis should have followed so closely upon the analysis of the elements of our flora that duplications would promptly have been discovered and the relation of each element to the other detected and stated.

We are on the eve of a new era of reconstruction. Already the pendulum is swinging back toward greater conservatism. The dismemberment of genera and the multiplication of species proceed more cautiously. This grows out of the revitalized aim, "make it easier for others to know plants."

Studies of Teratological Phenomena in Their Relation to Evolution and the Problems of Heredity: I. *A Study of Certain Floral Abnormalities in Nicotiana and Its Bearing on Theories of Dominance:* ORLAND E. WHITE.

Nicotiana plants showing petalody were selfed and progeny grown from them. In one race the abnormal character was extremely variable, some plants showing a large expression, other plants showing it only to a slight degree. This race varied in many other characters, proving the mother plant to have been very heterozygous. In another race, the abnormality was reproduced in all the progeny to the same degree as in the mother plant. With the exception of pollen color, no variation in other characters occurred in this race, indicating that it was largely homozygous in its hereditary constitution.

Pistillody originated as a discontinuous variation and was inherited in the same manner, crosses with the normal in one case giving in F_2 a progeny closely approximating a simple 3:1 ratio. In two hybrid F_1 families, it was completely recessive, while in what appears to be another hybrid F_1 family, it is wholly dominant. The first two families differ from the last family in a large number of characters, as the ancestry of the latter involves another species.

The catacorolla race of *Nicotiana* originated through a discontinuous variation. When crossed with normal races, the F_1 progeny were either intermediate in character or absolutely normal, though the individual F_1 progeny from each cross showed no variation among themselves. Great variation existed between the different pollen parents of many of these F_1 individuals.

As a whole, the data secured from hybridizing races of normal plants with those possessing the three abnormalities discussed above support the view that dominance and recessiveness are not in any way attributes of the factor or "character" in itself, but are the result of the factor expression plus the modifying influence of the environment, whether genotypical (all the other genetic factors of the organism not primarily concerned in the transmission of a particular character) or external (soil, climate, etc.). The variability of the catacorolla expression in the 119 F_1 plants of (—4—1*A* × 119 normals) is striking supporting evidence that this conception of dominance is the most tenable of those recently advanced by genetics.

Observations on the Behavior of Some Species on the Edges of their Ranges: ROBERT F. GRIGGS.

In the Sugar Grove region of central Ohio about 125 species, 13 per cent. of the native flora, reach their territorial limits. These plants are of diverse geographical affinity stretching away in every direction. More than half are abundant in many stations; only $\frac{1}{10}$ are rare; 21 are outliers far from their next station; 27 range continuously up to their limits; 77 reproduce well; only 18 reproduce poorly. The success of the seedlings in meeting plant competition is apparently more important than success of the reproductive apparatus. The theory that plants are confined to their optimum habitats at their termini does not accord with observation. On the contrary, some plants occupy the most unfavorable habitats, being forced by competition to grow where they can find room. The causes of the termination of these ranges is not evident. Climatic adaptability is evidently the limiting factor restricting the spread of species, but there does not appear to be such a climatic adjustment in the present instance, for most of these termini appear not to be stable, but are either advancing or retreating. There are tension zones between the different spe-

cies similar to the tension zones between ecological associations. By observation of these geographical tension zones it is possible to detect the trend of geographical movements. The indications at Sugar Grove are that Boreal types are giving way to others from the west and south. (To be published in the *Bulletin of the Torrey Botanical Club*, January, 1914.)

Variations in Iowa Oaks: B. SHIMEK.

Iowa occupies a peculiarly favorable position for the study of variations in oaks. Here northern, southern and eastern forms meet, and many of them appear in groves bordering the prairies.

Perhaps because of this, great variation is exhibited by many plants, those of the oaks being among the most striking and interesting.

The paper deals especially with variations in leaves and acorns, though other characters receive attention. Seventeen species and varieties are reported from the state, but chief emphasis is placed on variations in *Quercus macrocarpa*, *Q. alba*, the *Q. acuminata* group, *Q. rubra* and the *Q. coccinea* and *Q. velutina* group. The difficulty in determining species is considered and the value of specific characters is discussed, and special attention is given to the discussion of such disputed species as *Quercus coccinea*, *Q. ellipsoidalis*, *Q. boreale*, *Q. velutina*, *Q. texana* and *Q. Schneckii*.

The distribution of some of the species is discussed, and the record of the range of distribution of several species is corrected.

Segregation of Characters in First Generation Hybrids from Stable Species of Œnothera: GEO. F. ATKINSON.

The parents are stable wild species of Œnothera (*Œ. nutans* Atkinson & Bartlett, and *Œ. pycnocarpa* Atkinson & Bartlett),[1] found growing in the vicinity of Ithaca, N. Y. They have been cultivated through two generations. They differ in 25 to 30 clearly observable characters (a close analysis will reveal more) distributed in rosettes, stems, stem leaves, bracts, flowers, habit and propagation. Reciprocal crosses give rise to hybrids which show segregation of characters in the first generation. A number of the characters are contrast characters and behave as unit characters in segregation into twin and tripled first-generation hybrids.

Isomorphism in Capsella Hybrids: HENRI HUS.

In an earlier paper, presented at the Cleveland meeting, the presence of a gene N, to which the narrow character of the earlier leaves is due, was demonstrated for *Capsella Bursa pastoris Setchellii*. This form was shown also to contain Shull's gene B, responsible for the deeply incised primary lobes, as well as for the presence of secondary lobes. At the time it was thought that in the F_1 generation of a plant of the partial zygotic constitution $BbNn$, the combination BN was not formed (gametic repulsion). Experiments carried on during 1913 have demonstrated that this combination does exist and also that, whenever a plant is homozygotic for N, the identical external appearance obtains, independent of whether the remainder of the ascertained zygotic constitution is BB, Bb or bb. Such combinations always yield the form *arachnoidea*.

On Physiological Isolation in Types of the Genus Xanthium: CHARLES A. SHULL.

Remarkable variations in the burs of what has been considered *Xanthium canadense* Mill. have been noticed in Kentucky, in Kansas and elsewhere during the last several years. Three distinct types were selected in the fall of 1912 from the local flora where all were growing together on the same soil under identical conditions, for breeding experiments. These types have bred true to the parental generation, notwithstanding their close proximity in the field and their unguarded pollination. Differences were noticed in the burs, seeds, leaves, pigmentation, etc., and in the length of time required for the development of the reproductive organs. Because they bloom at different ages the types tend to remain distinct, although there is evidence that occasional hybrids may occur under natural conditions. The genus needs revision based upon experimental investigation.

On an Abnormality in the Flower of the Bellwort (Oakesia sessilifolia) which Prevents Seed Formation: A. F. BLAKESLEE and A. F. SCHULZE.

The abnormality consists in transformation of stigmas into anthers containing pollen grains which in sugar solutions germinate, as well as pollen from the normal stamens of the flower. Such abnormal flowers do not set seed.

Variability in a Vegetatively Pure Line of a Hermaphroditic Mucor: A. F. BLAKESLEE.

Separation cultures from a single spore sowing of the mucor tested gave a small percentage of colonies sharply different from the stock form. The variations consisted in absence and increase or decrease of zygospore production, peculiarities in color, density and rapidity of mycelial growth, differences in height of mycelial filaments, the almost exclusive production of yeast-like cells in

[1] See *Rhodora*, 15: 83–85, 1913.

place of a filamentous mycelium, the production of a filamentous mycelial growth devoid of sporangia, and a partial change at least toward the dioecious condition. Some of these variants are surely temporary conditions for they tend eventually to revert to the normal type. Others may be more permanent but have not been sufficiently investigated. All, however, tend partially at least to reproduce the new characters and some have for several sporangial generations kept their peculiarities in gross cultures during the few months it has been possible to propagate them. Many of them would undoubtedly be described as distinct species by specialists in the group.

The Development of Amanitopsis vaginata and Lepiota clypeolaria: GEO. F. ATKINSON.

Amanitopsis vaginata.—The primordium of the pileus arises in the middle of the upper part of the young carpophore as a dome-shaped area. This soon differentiates into an upper portion, the pileus primordium; and a lower one, the hymenophore primordium. By surface and marginal growth (the latter being epinastic) through the enveloping fundamental tissue, the pileus is formed. By downward and obliquely inward growth of the hymenophore through the fundamental tissue toward the stem fundament the primordial tissue of the lamellæ is formed. This gradually becomes differentiated into the primordia of the lamellæ, the trama of the gills being continuous with the trama of the pileus and the surface of the stem. There is no internal annular gill cavity as in *Agaricus*, *Lepiota*, etc. The fundamental tissue enveloping the primordia of pileus, hymenophore and stem is the "universal veil," or in fact gives rise to it at a quite late period in the organization of the pileus when an outer zone of the developing pileus changes into a gelatinous cleavage layer.

Lepiota clypeolaria.—Before any evidence of internal differentiation of the primordia of the pileus, hymenophore and stem, the young carpophore presents an outer duplex zone, the "universal veil" of Fries. The inner portion of this zone consists of a thin layer of subpseudoparenchymatous cells, the outer portion of long radially extending threads. After the origin of the stem and pileus fundaments, this "universal veil" is for some time separated from the pileus and stem by a zone of loose fundamental tissue. In the further differentiation of the pileus the surface threads grow through this intermediate zone of fundamental tissue and tie into the inner zone of the "universal veil" so that the latter becomes "concrete with the surface of the pileus," no cleavage layer being formed.

A Preliminary Note on Spore-formation in Cyathus: GUY BISBY.

Practically no work has been done in recent years on this genus, making an examination of some interest. The nuclear divisions in the basidium is followed in *Cyathus vernicosus* by a nuclear division in the spore, making this species binucleated, whereas in *Cyathus stercoreus* the spores remain uninucleated. This cytological feature should be of advantage as a systematic criterion. Hyphæ growing from germinated spores have been observed, in forming anastomoses, to be met by a short protuberance from the hyphæ approached, apparently responding to some sort of attraction.

Variation in the Sporangia and Spores in the Saprolegniaceæ and its Bearing on their Classification: W. C. COKER.

Original observations on such variations are reported and the literature examined. It is concluded that while there is great variation in size, arrangement and behavior of both spores and sporangia, these (with possibly a single exception) are not of a character to confuse our present conception of genera in this family.

A Peculiar Water Mold: W. C. COKER.

A new species is reported from Chapel Hill, N. C., that exhibits in a confusing way certain of the reproductive peculiarities of *Achlya* and *Saprolegnia*. The spores on emerging swim away in part while others remain attached to the sporangium tip.

Occurrence and Periodicity of Water Molds at Chapel Hill, N. C.: W. C. COKER.

The results of about 450 collections are given, showing the relative abundance of the species found and their periodicity in so far as it exists. About 20 species are discussed.

Foliage Resistance of Different Varieties of Potatoes to Phytophthora infestans: I. E. MELHUS.

A study has been made of the varietal resistance of potatoes to *Phytophthora infestans* by artificially infecting the foliage. Varieties reputed to be either resistant or susceptible were grown in the greenhouse and subjected to favorable conditions for *Phytophthora* infection. The conidia of the fungus were germinated in water at optimum temperature conditions (about 13° C.). The resulting zoospore suspension was sprayed in the lower surface of the leaves of the healthy,

vigorous plants from 6 to 12 inches tall. Plants thus treated were held in a moist atmosphere at 20° to 25° C. over night and removed the following morning.

It is believed that by this method it is possible to learn the relative resistance of any variety without growing it under field conditions.

Plus and Minus Strains in the Genus Glomerella: C. W. Edgerton.

Cultures of *Glomerella* from different hosts have been obtained which show the presence of two different strains, these being provisionally called plus and minus strains. The plus strain produces normal perithecia in clumps or masses. The minus strain produces perithecia, usually immature, scattered profusely over the surface of the culture medium. When these two strains are placed in the same plate and allowed to grow together, a dense black ridge of normal perithecia develops on the boundary line. The two strains of one of these fungi have been carried for over three years and are still producing perithecia abundantly. That there is a fertilization between the two straine has been proven by isolating single asci from tho boundary line between the two etraine and allowing them to grow into colonies. These colonies usually produce both straine.

The Homology Between Spore-forms in the Ascomycetes: C. R. Orton.

It has been pointed out in the ruets that there is a very striking morphological similarity between certain heterœcioue species. This morphological likeness may be termed homology. It is pointed out in this paper that a eimilar homology exists between the conidial and ascigerous stages of certain Ascomycetes with respect to morphology of thoir spores. Examples are cited and discussed which show the likeness as well as the apparent exceptions. It is hoped that this fact may be of value to the mycologist and plant pathologist as a guide to life-history studies.

A Contribution to the Life History and Physiology of Cylindrosporium on Stone Fruits: B. B. Higgins.

A careful study of the life history of this parasite has brought to light a very interesting polymorphism. Four spore forms were found to be genetically connected in the life cycle as follows: Typical *Cylindrosporium conidia,* produced on delicate stromata in spring and summer; microconidia, produced on the eame stromata in late fall; ascospores, produced in apothecia in the dead leaves during the following spring; and apothecial conidia, produced later in the same apothecia following the discharge of the ascospores. All of these except the microconidia are capable of producing infection on the host plants.

A study of the morphological and biological characters of the organism from eight species of *Prunus* showed that the forms under consideration fall naturally into three species, one on each of three more or less distinct divisions of the host genus.

North American Species of Peridermium on Pine: J. C. Arthur and F. D. Kern.

The authors published a paper covering this ground in 1896, since which time much information has been added to previous knowledge, which the authors now propose to summarize. Some of the former names have been reduced to synonymy, chiefly as the result of culture work, and two new species are established, one from California and one from Guatemala. Some three or four species have been introduced from Europe, and are yet local. Doubtless the greatest economic interest centers about the caulicolous forms, native and foreign, and these have been discussed with coneiderable fulness.

Transpiration of Silphium laciniatum L.: L. A. Giddings.

The experiments discussed in the present paper were carried on with *Silphium laciniatum* L. Thie plant was selected for experimental purposes because of the fact that it is a xerophyte growing in very dry exposed prairie regions and becauee, being taller than most of our native prairie plants, it offers opportunities for the study of normal transpiration in relation to evaporation at different altitudes above the surface of the eoil.

The paper includes a discussion of the experiments carried on in the laboratory and in the field. A part of the experiments were carried on in tho plant physiology laboratory of the State University of Iowa. The field experiments were carried on at the Macbride Lakeside Laboratory on West Lake Okoboji during the summer of 1912. Material for the study of the structure of the leaf was collected at the same time that the field experiments were being performed.

In the laboratory special attention was given to the effect of increased wind velocity on the rate of transpiration. Evaporation experiments were run with the transpiration experiments for comparison. In the field experiments attention was also given to the effect of wind velocity on

the rate of transpiration, but in these experiments relative humidity was also carefully studied and a comparison between the time of day when the lowest relative humidity occurred and the time of day when evaporation and transpiration were greatest. The rate of transpiration of leaves taken at different heights was studied, together with evaporation at the same heights.

The laboratory experiments showed that the rate of transpiration increased with wind velocity up to a certain limit, after which it did not increase in proportion to the increase in wind velocity. As a rule, in the field experiments transpiration was greatest before evaporation had reached a maximum.

The Effect of Certain Surface Films and Powders on the Rate of Transpiration: B. M. DUGGAR and J. S. COOLEY.

It is commonly observed that leaves of plants sprayed repeatedly with Bordeaux mixture may remain green and healthy, towards the close of the season, several weeks after unsprayed leaves free from fungous diseases have ripened. The experimental work reported up to this time has afforded no data indicating differences of sufficient magnitude between the activities and unsprayed leaves to account for the extended vegetative period. The experiments here reported were made for considerable periods of time with standardized castor bean leaves in potometers and with large numbers of potted tomato plants. Bordeaux mixture, aluminium mixture, lime, and certain other film-forming liquid and powders were employed. In every case the rate of transpiration was higher in the Bordeaux sprayed plants than in the controls, or as compared with the standard. The important differences make it necessary to give weight to increased transpiration in any explanation offered.

The Relation Between the Transpiration Stream and the Absorption of Salts: HEINRICH HASSELBRING.

During the winter of 1908–1909 experiments were conducted at Santiago de las Vegas, Cuba, in order to determine the comparative transpiration of tobacco plants under cheese-cloth shade and in the open ground. For this purpose plants were grown in galvanized iron tanks which were set into outer encasing tanks permanently sunk in the ground. Six tanks were placed among the plants of a field of tobacco grown under cheesecloth, and six were set in an adjoining tobacco field not shaded. The quantity of water transpired by the plants in the tanks was determined by daily weighings, the quantity transpired being replaced each day. At maturity the leaves, stems and roots of each plant were harvested separately, dried and ground. The ash was determined in water-free samples of the ground material. From the data the total ash of the plants was calculated.

The plants grown in the open absorbed about 28 per cent. more water than those grown under shade. The plants which absorbed and transpired the greater quantity of water contained both the smaller percentage and the smaller absolute quantity of ash.

It appears, therefore, that the absorption of salts by roots is independent of the absorption of water, and that the transpiration stream does not exert an accelerating effect on the entrance of salts.

Relation of Transpiration of White Pine Seedlings to Evaporation from Atmometers: G. P. BURNS.

An attempt was made to express the data recorded by meteorological instruments in terms of plant physiology and thus give them a botanical significance. The experiments were conducted in the state forest nursery under different degrees of "shade."

A comparison of the water loss from white and black atmometers with that from white pine seedlings under three conditions of shade used gave the following coefficient of transpiration:

Half shade	.0088 for black atmometer.
	.0087 for white atmometer.
No shade	.062 for black atmometer.
	.084 for white atmometer.
Full shade	.036 for black atmometer.
	.044 for white atmometer.

By use of these coefficients it is possible to calculate the water loss from white pine seedlings from the evaporation from the atmometers.

Half shade reduces the transpiration and the evaporation, but the graphs show that the response of the plants and the atmometers is not identical. The decrease in water loss due to "shade" for the first part of August, 1913, was as follows: black atmometer 50 per cent., white atmometer 44 per cent., white pine seedling 70 per cent.

Plants grown under the three conditions studied showed great variation in structure, in the amount of ash, and their chemical composition. The amount of water transpired by the no-shade plants was many times that transpired by the

plants in half and full shade, but the per cent. of ash, figured on a dry matter basis, is less in these plants than in either of the other two sets of plants.

Relative Transpiration in Rain-forest and Desert Plants: FORREST SHREVE.

Relative transpiration is defined as the ratio of the absolute transpiration of a unit area of leaf surface to the concurrent evaporation from a unit area of water. Its values give an index of the physiological controls of transpiration and of the action of light upon it. Relative transpiration and stomatal movement have been studied in several Jamaican rain-forest plants, with the general result that the two do not show a sufficiently close correlation to warrant the view that either is wholly controlled by the other.

A comparison of the rates of relative transpiration in rain-forest and desert plants shows them to be of the same order of magnitude in the two groups, as investigated under the conditions of their native environments, in Jamaica and in Arizona. Since the annual evaporation total in Arizona is ten times that in Jamaica, it follows that the absolute transpiration per unit area in plants of the desert is approximately ten times as great as it is in the rain-forest.

Seasonal Variations of the Osmotic Pressure of Pool, Pond and Stream Waters: EDGAR N. TRANSEAU.

Freezing-point determinations of the osmotic pressure of the natural waters of pools, ponds and small streams in central Illinois, made at intervals during the year 1913, have shown the following general results:

1. The osmotic pressure, expressed in millimeters of mercury, varied from 59 to 407.

2. The highest pressures were recorded during early spring when the water levels were highest.

3. The lowest records were made during the middle of September when the levels for the year were lowest.

4. Contrary to the statements often made, when the water level of ponds and pools lowers in late spring and summer, the osmotic pressure of the water is not increased, but is often greatly diminished.

5. When streams are reduced to pools, the water may have a higher pressure; as the pools dry up the pressure is diminished.

6. There are sudden and considerable variations in the pressure, sometimes coincident with weather changes, development or decay of algæ, etc., but sometimes without apparent connection with other known factors.

The year 1913 was an exceptionally favorable one for testing the relation between lowering water levels and concentration, as there were no rains of consequence between the middle of April and the middle of September.

Zoospore Formation in Characium acuminatum: GILBERT MORGAN SMITH.

The mature plant is multinucleate and contains 16, 32 or 64 nuclei at the time that zoospore formation takes place. In the growth of the alga the nuclear divisions are mitotic and all nuclei divide simultaneously. There may be more than one pyrenoid present and the shape of the pyrenoid is quite irregular. Very thin starch plates are found around the pyrenoid, while other plates of stroma starch, probably derived from the pyrenoid, are found scattered throughout the cytoplasm.

The zoospores are formed by progressive cleavage. Cleavage takes place by a furrowing in of the plasma membrane. The first cleavage furrows are transverse and then longitudinal cleavage furrows cut the protoplasm into multinucleate masses. These multinucleate masses are then cut into angular uninucleate protoplasts by further cleavage. There is no division of the pyrenoid, but it remains unchanged till cleavage has been completed, when it disappears. The angular uninucleate protoplasts then become ovoid and a pyrenoid is formed *de novo* in each one. These are the zoospores which are liberated by the rupture of the old mother cell wall.

A Preliminary Report on the Isolation and Identification of the Enzymes of Fucus vesiculosus: B. M. DUGGAR and A. R. DAVIS.

Peculiarities in the carbohydrate and nitrogen metabolism of the Fucaceæ make desirable a determination of the enzyme content of the growing tissues. Employing a variety of methods, no evidence has yet been found to indicate the presence of any of the commoner carbohydrases except cellulase. The commoner esterases are likewise absent, but amidases are well represented. Urea, especially, is rapidly transformed and urease is apparently widely distributed in the tissues. Oxidases have not been detected by any of the usual methods.

Relation of Certain Grass-Green Algæ to Elementary Nitrogen: JACOB R. SCHRAMM.

The number of species of algæ in which free nitrogen fixation has been investigated under pure cultural conditions is relatively small—represent-

ing not more than four or five genera. By a pure culture here is understood one containing a single species of alga free from all other organisms. What work has been done with pure cultures has led invariably to the conclusion that these forms are unable to fix free atmospheric nitrogen both in the presence of and absence of combined nitrogen and energy-furnishing materials. It is by no means certain, however, that forms do not exist which under one or all of these conditions are able to utilize elementary nitrogen. This thought is especially justified when the small number of free nitrogen-fixing species among the bacteria are considered.

By a variety of methods approximately 25 species were isolated in pure culture. Of these, two were blue-greens, 2 diatoms, and the remainder grass-greens. Seven species of the latter were tested for free nitrogen fixation in the complete absence of combined nitrogen. The effect of a slightly elevated temperature was determined in a duplicate series maintained at a temperature of from 29.5 to 30.5° C.

No fixation was observed in any of the species and, unlike certain fungi, no favorable effect was exercised by the higher temperature.

Indications Respecting the Source of Combined Nitrogen Used by Ulva lactuca: G. L. FOSTER.

Laboratory cultures of *Ulva lactuca* in seawater showed increased growth over that of the controls, when ammonium nitrate, urea or acetanide was added. Na-asparaginate did not increase the growth. Dimethylanilin and acetanilide were extremely toxic.

Parallel experiments in which the same compounds were added to artificial sea-water less nitrogen, gave similar results.

The Influence of Etherization on Certain Enzymatic Activities of Bulbs and Tubers: M. M. McCOOL.

The experiments reported deal chiefly with the relative activity of diastases, oxidases and catalase in etherized and natural bulbs and tubers. Material from the two sources indicated differ materially in the activity of the enzymes. Diastatic action is greater in the etherized tissues; and this is also true for the action of oxidases and peroxidases. Catalase activity is, however, diminished by etherization.

On the Tracheary Origin of the Resin Tissue of the Conifers with Special Reference to Abies balsamea: R. B. THOMSON.

After a careful survey of the resin tissue in the whole Conifer series, the conclusion has been reached that the ligneous resin tissue of the Conifers owes its origin to the modification of tracheary elements. This seems self-evident when it is considered that the Cordaitean forms, from which the Conifers are generally conceded to have arisen, have wood which is wholly tracheary. This view is directly opposed to that of Penhallow, who regards the resin tissue as derived from parenchyma, a view which is no doubt responsible for the recent theory of Kirsch that the vertical resin canals of the pines are proliferated from the *parenchyma* of the medullary rays.

In *Abies* Penhallow found transitions between the parenchymatous cells of the resin cysts and parenchyma-shaped tracheary elements. These he interpreted as evidence of the transformation of parenchyma into tracheary elements, whereas the writer presents evidence to show that both these and the parenchyma elements are derivatives of tracheids, the chief point being that these elements or combinations of them and the parenchymatous ones are *in vertical series coterminous* and *in the same radial sequence with ordinary tracheids*. They are thus derived from the same cambial cell which ordinarily gives rise to a tracheid. The modification occurs in association with the medullary rays, which are the only source of preservative in the most ancient fossil woods.

Cycad Pitting: H. B. SIFTON.

The pits on different parts of individual tracheids of the Cycads differ. The terminal ones, and those on the sides touching parenchyma tissue are more primitive than the others. In arrangement the pits are opposite or alternate indiscriminately, and are even quite commonly scattered or in small groups of two or three, facts which show that the arrangement of pits is not a feature of so great phylogenetic importance as has been thought. In cases of scattered or group pitting, there is present a probable precursor or primitive form of the "bars" or "rims" of Sanio, structures which have not been previously described in the Cycads, the only group of living Gymnosperms in which they have not been found.

A reexamination of type material of *Cordaites missouriense* (*C. illinoisense*) reveal several important features not mentioned in Penhallow's brief description.

The pitting is more primitive near the ends of the tracheids, and beside the medullary rays, than on other parts. This is shown by an increase in the number of rows of pits, and by the greater

dimensions of the pores. As many as six rows may be found where the tracheid touches the ray cell, and here the pores may extend considerably beyond the border of the pits. Again, in arrangement, the pits, though usually alternate, may be opposite, and are often scattered.

One remarkable feature is that many tracheids have bent ends, usually at the rays. These bent ends reach over several tracheids, and thus afford a means for radial conduction. Such tracheids have long been known in the Araucarineæ and are considered to be ancestral to true ray tracheids. They are for the first time described in a Cordaitean form.

Trabeculæ are present in many tracheids; a feature which has not been noted previously among Cordaitean forms. Peculiar wandering parenchymatous cells are also found associated with the medullary rays.

Tyloses: A Study of Their Occurrence and Practical Significance in Some American Woods: ELOISE GERRY.

In this study of the occurrence of tyloses in wood from trees of commercial size grown in the United States, 203 specimens were examined. The 143 specimens of hardwoods include 94 species belonging to 45 genera, 24 of which contained tyloses. The 60 specimens of conifers included 45 species belonging to 13 genera, 1 of which contained tyloses. Of the total 139 species examined, 56 belonging to 25 genera[2] contained tyloses.

Tyloses were found in the sapwood of all the species where their presence was established in the heartwood.

Well-developed tyloses were found in the outermost rings near the bark of 30 species of hardwoods.

True tyloses occur in the wood tracheids of certain pines, principally of the white pine group.

Epithelial cells sometimes effect a partial or even a complete tylose-like closing of the resin canals in *Pinus, Larix, Picea* and *Pseudotsuga.*

A considerable proportion of the vertical canals, even in the heartwood of the pines, are wholly or partly open.

Tyloses act like a natural filler in the hardwoods.

The woods where tyloses are abundant are, as a rule, durable.

[2] *Æsculus, Fagus, Liquidambar, Liriodendron, Magnolia, Oxydendrum, Platanus, Populus, Salix, Castanea, Catalpa, Celtis, Chilopsis, Eucalyptus, Fraxinus, Hicoria, Juglans, Morus, Quercus, Rhus, Robinia, Sassafras, Toxylon, Ulmus, Pinus.*

Tyloses, because they are very impermeable to air, water and creosote, reduce the penetrance of the woods in which they are strongly developed, thus decreasing, for instance, the tendency for such woods to become water-logged.

The presence of tyloses closing the vessels of a hardwood does not, however, prevent the penetrance of a preservative such as creosote into the other wood elements.

(*To be concluded*)

GEORGE T. MOORE,
Secretary

SOCIETIES AND ACADEMIES

THE TENNESSEE ACADEMY OF SCIENCE

THE annual meeting of the Tennessee Academy of Science was held in Furman Hall, Vanderbilt University, Nashville, Tenn., on November 28, 1913. President Watson Selvage delivered an address relative to the aims and purposes of the Academy, and the following papers were read and discussed:

"A Natural Bridge of Tennessee in Process of Formation," by H. D. Miser.

"Physiographic Features of Tennessee," by L. C. Glenn.

"Development of the Phosphate Industry in Tennessee," by Lucius P. Brown.

"Caverns and Rock Shelters of the Cumberland Valley," by W. E. Myer.

"Food Preservation," by L. C. Bliss.

"A New Geological Map of Tennessee," by A. H. Purdue.

"Some Neglected Principles of Physiography," by A. H. Purdue.

"Some Early Topographic Maps," by L. C. Glenn.

The following officers were elected for the ensuing year:

President—L. C. Glenn, Vanderbilt University, Nashville.

Vice-president—W. E. Myer, Carthage.

Secretary—Roscoe Nunn, 1235 Stahlman Building, Nashville.

Treasurer—Archibald Belcher, Middle Tennessee Normal School, Murfreesboro.

Editor—James A. Lyon, Southwestern Presbyterian University, Clarksville.

The president appointed as members of the executive committee, S. M. Bain, University of Tennessee, Knoxville, and E. J. McCroskey, Lebanon.

ROSCOE NUNN,
Secretary

SCIENCE

FRIDAY, FEBRUARY 20, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PLEISTOCENE HISTORY OF THE MISSOURI RIVER[1]

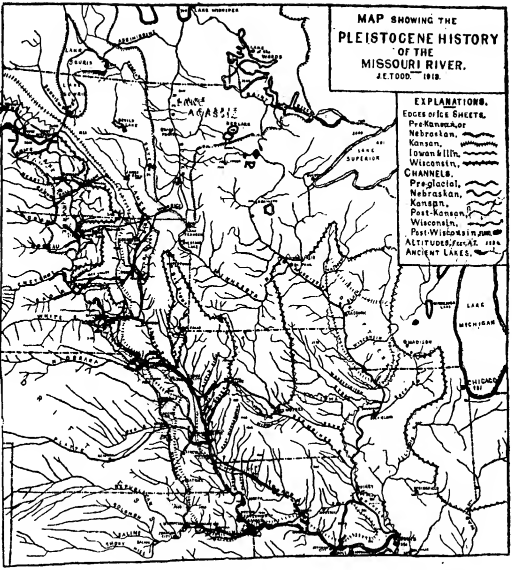
ASSUMING that one whom you may honor by election to this position of vice-president is expected to bring forward something concerning his special line of research, I have chosen the theme presented as my subject. It has been my lot to study more or less for the last forty years the relations of the Missouri River to the Pleistocene Ice.

This paper proposes to set forth some facts, some of them not widely known, with theories for their explanation, and to interweave the theories with sufficient speculation to form a consistent and not improbable story.

My personal examination covers only from the mouth of the Missouri to Bismarck, N. D., consequently I speak less intelligently of the region farther north.

The Missouri is not an old river geologically speaking. It has reached maturity over most of its course, but that is the result of the softness of the rocks over which it flows, rather than of the length of time it has occupied its present course. Nor is the degree of maturity proportionate to the softness of the rocks. For example, through the Dakotas it is in very early maturity, the flood plains are narrow and the trough is narrow and has steep sides, though the rocks are very soft, while in its lower course the breadth of its trough is quite strictly proportional to the softness of the rocks forming the bed of the present

[1] Address of the vice-president and chairman of Section E, Geology and Geography, American Association for the Advancement of Science, Atlanta, December 29, 1913.



stream. This indicates that the upper part of its present source is younger in time.[2]

The fact has long been recognized that the Ohio and Missouri rivers mark approximately the southern limit of the great ice sheet of the Pleistocene, as though the latter had exercised a controlling influence in the courses of the former. The Ohio, being more accessible, has been studied by several geologists, but by none more carefully than by Professor W. G. Tight.[3]

There the general preglacial drainage was toward the northwest and was changed to the southwest. In the case before us we shall find reason to believe the preglacial

[2] Missouri Geol. Survey, Vol X., Pl. XX., and U. S. G. S. Bull. 158, Pl. XXIII.

[3] Professional Paper No. 13, U. S. G. S. (1903), "Drainage Modifications in Southeastern Ohio and Vicinity."

drainage was largely to the northeast and the ice changed it to the southeast.

The exceptional or anomalous course of the present Missouri is shown by the following facts. The Missouri at Ft. Stevenson, where it turns sharply to the southeast, is 1,720 feet A. T., while the Souris River, forty miles northeast, is 200 feet lower and from there is an open course to Hudson Bay, 900 miles away in a straight line. Instead of finding its way thither it reaches the Gulf of Mexico at just about twice that distance. To be sure other rivers show similar eccentricities, but they have mountain ranges to explain their action. Here there is nothing of that sort, but, on the contrary, only soft rocks lying horizontally. Moreover, the tendency for the Missouri to run at right angles to the direction of slope is shown further by the following facts: at Bismarck it is 220 feet higher than the James River at Jamestown, 105 miles east, and 400 feet above the Chyenne, 10 miles further east; at Pierre it is about 200 feet above the James, 105 miles east, and at Chamberlain 100 feet higher than the James near Mitchell, 66 miles east. At Sioux City the Missouri is 130 feet higher than the Des Moines at Ft. Dodge, 110 miles away, and at Council Bluffs 200 feet higher than the Des Moines, 115 miles east. At Kansas City it is about 300 feet higher than the Mississippi at Hannibal, about 200 miles east. This illustrates strikingly the tendency of the Missouri to follow the strike of the surface rather than the dip.

This anomaly is commonly ascribed to the influence of Pleistocene ice sheets. In general it is safe to suspect that the preglacial drainage of the region was toward the east or northeast. This agrees with the fact that streams along the line of the present Missouri trend eastward, except in the vicinity of glacial deposits, viz., from the vicinity of Williston, N. D., to Kansas City, Missouri.

A. THE PROBABLE PRE-PLEISTOCENE DRAINAGE ALONG THE LINE OF THE PRESENT MISSOURI RIVER

The conclusions offered here should be valued carefully according to their weight. Some may be considered fairly established; others are given only provisionally. Moreover time permits us to indicate them only briefly without stating them so fully as might be desired. The main tributaries of the Missouri are from the west and have uniformly a persistently eastward direction. Furthermore, they may be grouped into clusters of two or three which converge as they approach the Missouri, and in several cases corresponding valleys are discoverable east of the Missouri. We will consider these groups in order.

1. *The Missouri and Little Missouri Rivers.*—The upper Missouri keeps a quite persistent easterly course from the mountains till it approaches the glacial drift near Nesson, N. D. The Yellowstone flowing northward joins it 40 miles west at Buford. The Little Missouri, with a course parallel to the latter, formerly joined the Missouri at Nesson, but now it leaves its old channel about 50 miles south of its old mouth, turns east and joins the present Missouri near Ft. Berthold. In view of these facts, probably the first suggestion which comes to mind is, that before the Pleistocene the Little Missouri joined the Missouri at Nesson and both continued their way eastward to the bend of Souris River and thereby reached Hudson Bay. This seems to agree with the fact that a terrace and old channel more than 100 feet higher than the present river leads eastward over a dozen miles into the morainic drift, but such a conclusion is forbidden by the discovery of a channel corresponding in height and size several

miles southeast leading across a large bend of the Missouri in a southeast direction. This seems to show quite clearly that the Missouri occupied this channel before the ice came. If this was true it is probable that the river continued south of east to Ft. Stevenson, where the present stream turns sharply southward. Knife River joins it several miles further south, and from the direction of the valleys and the fact that there is an unusually large valley for a small stream, Snake Creek, coming in from the northeast at Ft. Stevenson, it seems possible that the Knife and Missouri formerly joined near Ft. Stevenson and ran northeast to the Souris. The divide between is heavily covered with drift and we know nothing of the preglacial surface below, but some maps show a deep notch in the east front of the divide nearly north from Ft. Stevenson and in line with the northeast course of the Souris on the south side of its great bend. The height of the Missouri at Stevenson is close to 1,700 feet A. T.; of the Souris, 45 miles away, is about 1,500 A. T.; the height of the divide between, not less than 2,100 A. T. The altitude of the terrace at Ft. Stevenson is about 1,790, which would indicate that the old channel, if there, is filled at least 230 feet with drift, which is no uncommon thickness.

The Souris at present is several feet below the bottom of the drift there, and 50 to 75 feet below the level of the Souris plain of Lacustrine origin. The surprisingly low altitude of the Souris compared with that of the Missouri is most reasonably explained by great glacial erosion of the soft rocks underlying the region. The preglacial drainage doubtless had a much gentler slope than the present surface would indicate.

2. *The Heart and Cannon Ball Rivers.*—The Heart River joins the Missouri at Bismarck at 1,620 A. T. It shows a conspicuous terrace west of Mandan, which rises 110 feet higher. Southeast of Bismarck a terrace and broad valley-like depression runs up Apple Creek to Menoken, 15 miles east, then southeast as much further, to the southwest end of Long Lake. Its bottom fluctuates a little above and below 1,750 A. T. Cannon Ball River joins the Missouri about 30 miles south of Bismarck, opposite the mouth of Long Lake Creek, which drains a valley running north-northeast, in line with the lower course of Cannon Ball to the west end of Long Lake, and to the valley already mentioned as coming from Bismarck. Long Lake occupies a valley 25 to 30 miles long and 4 or 5 miles wide, continuing in the same direction, past Dawson, on the Northern Pacific railway, until it becomes filled with glacial deposits and untraceable. The altitude of the bottom of the valley near Dawson is 1,738 A. T. A lobe of the ice of the Wisconsin stage pushed up this valley as far west as Sterling. We have, therefore, quite convincing evidence that Heart and Cannon Ball rivers, at some time, most probably in preglacial times, flowed over the present divide between the Missouri and James rivers. Their course further east has been obliterated by the marked erosion and deposition of the various ice sheets, which have successively occupied the region further east.

3. *Grand and Moreau Rivers.*—The Grand River turns southeast before reaching the Missouri, apparently to go around the south end of a high ridge which lies just east of the latter stream. The Moreau probably joined it near this point not far from Mobridge. Both streams have several terraces along their valleys; those about 200 feet above the present stream are prominent and correspond to a broad valley which runs northeast 20 to 25 miles, where the surface becomes morainic and

rises gradually to the lowest point of the divide below the Missouri and James near Hillsview, at an altitude of 1,850 A. T. Thence is a gradual descent to the valley of the James near Aberdeen. That the axis of a lobe of ice lay along this line during the Wisconsin stage is shown by hills lying to the north and south, and these with the before mentioned ridge lying along the east side of the Missouri are all covered with morainic drift. It is not difficult to conceive that the preglacial Grand and Moreau, flowing 200 to 250 feet higher than now, went east to the James.

4. *Cheyenne and Bad Rivers.*—These constitute another pair which, probably uniting near Pierre, passed east to the James River Valley. The Cheyenne at that time lay further south in its lower course, as is indicated by broad high terraces. It passed south of Sully Buttes and eastward through the northern part of Hyde and Hand counties and the valley of Turtle Creek to the James near Redfield. Bad River may have joined it near the mouth of Okobojo Creek or may have followed the present course of the Missouri to the mouth of Medicine Knoll Creek and up its course to a junction in eastern Sully county. There is similar and clearer evidence of a former ice lobe here than that found in the last case, viz., the moraines to the north and south and along the east bluffs of the Missouri. The valley is so well marked that it is popularly known as the Ree Valley. The hills north and south rise to 2,000 A. T. The lowest part of the divide in the valley is 1,650 to 1,675 A. T. The depth of the glacial drift may reach 200 to 250 feet.

5. *White River.*—The course of this river is about as easily traceable east of the Missouri as that of Heart River, and for a similar reason, viz., because the ice did not quite reach to the Missouri in its valley. There are several prominent terraces along White River, one 200 to 250 feet above the stream. At about the same level is a valley about two miles wide which runs from the mouth of that river northeast nearly 25 miles, where it is crossed by a moraine a little west of White Lake. White Lake may be considered in it and the depression continues down the Firesteel to the James, and then northward to join the Cheyenne. Red Lake occupies a portion of this same valley. Several miles south of White River is the old divide between it and Niobrara River. It stands out prominently as a high range of flat-topped buttes capped with Tertiary sandstone. The gorge of the Missouri through it is 750 feet deep. The preceding rivers after reaching the James Valley, which was then imperfectly developed, converged to a point northeast of Aberdeen, where there is a prominent gap in the highland east of the James, a little north of the south line of North Dakota. It is the wide valley of an intermittent stream called the Wild Rice River. That stream heads close to the James River and the divide between is not over 30 feet higher than the latter. The Wild Rice descends 300 feet in 60 miles and joins the Red River of the North.

We may conclude, therefore, that White River turned northward, joined the Cheyenne near Redfield and Grand River north of Aberdeen and met the Cannon Ball and Heart rivers coming from the north and all formed an important stream which found its way eventually to Hudson Bay, as Red River does to-day. It is possible that the two from the north may have found courses along the Cheyenne and not joined those from the south till later. No trace of the old courses could be found now, for the erosion of the Pleistocene must have lowered the surface scores of feet below the bottoms of the old valleys.

6. *Niobrara River.*—The valley of this

stream as late as just before the Wisconsin stage of the Pleistocene has been clearly traced from a little south of its present junction with the Missouri, northeast past Springfield and Tabor, to the James a few miles northeast of Yankton. There is little doubt that its preglacial course was the same so far. Its altitude was probably 100 to 150 feet above the present, *i. e.*, 1,300 to 1,350 A. T. It may have been 100 feet higher still. That it belonged to a different system from those hitherto considered is favored by the following facts: (1) there is trace of an old divide crossing the James River south of Mitchell. The Sioux Quartzite rises to more than 1,200 A. T. and Cretaceous rocks overlive to a height of more than 1,300. As this is in the center of the valley it is reasonable to think that 100 feet may have been carried away by glacial erosion. (2) There is a line of high ridges lying across the James valley north of the Niobrara, as though they were a remnant of a divide. I refer to the Choteau Creek Hills, James Ridge and Turkey Ridge. (3) The few traces of preglacial surface in eastern Nebraska and western Iowa seem to call for a lower drainage level than is indicated farther north, and also farther south. In short there seems to be need of finding a drainage outlet eastward to the Des Moines, or else to postulate a recently formed syncline for which we know no other evidence.

We conclude therefore that the Niobrara turned south and followed the courses of the James and Missouri to the vicinity of Onawa, Iowa, thence east and northeast through Ida and Sac counties past Wall Lake and thence southeast along the Raccoon River.

This conclusion rests on a few apparently reliable reports from wells which show that the preglacial surface indicates a valley whose bottom is less than 900 A. T., in some cases less than 850. It has not been possible to outline the valley throughout, but half a dozen observations through Ida and Sac counties are most easily explained by such a theory. The fact that Wall lake lying on the summit formerly drained into Boyer River and now into the Raccoon, and another fact that the Boyer rises east of the crest of the divide, has first a course east of south and at this point turns southwest, are also most easily explained by the theory given.

There was a descent of about 350 feet from Sioux City to Wall Lake.

7. *Platte River of Nebraska*.—This stream presents difficulties which have not yet been satisfactorily solved. The lowest surface overlain with glacial deposits in their original position seems to be about 970 feet A. T. in the vicinity of Omaha and Council Bluffs. The lowest striated rock surface is about 1,000 A. T., except a ledge at Omaha reported by Dr. C. A. White, which was about 6 feet above the river, and may have been the result of the action of river ice. It is conceivable that till may have slumped 30 feet into more recent excavations without clearly showing the fact. There are numerous evidences of such slumping elsewhere along the trough of the Missouri.

Now there seems to be quite clear evidence, as will be explained in the next section, that in early Pleistocene there was a divide at least 900 feet A. T. near Leavenworth and that south of it drainage levels were considerably higher than north of it. There would, therefore, have been insufficient slope in that direction to have excavated down to 970 feet A. T. 150 miles away. We seem driven therefore to find some other outlet.

Could it have been through to the Des Moines by the old channel in Sac county? That would have had a steeper grade than by Leavenworth. We have not been able

to find any other route to the Des Moines half as probable, but it has been argued elsewhere[4] that eastern Iowa was formerly relatively considerably higher than now.

Could it have been southeast to the Grand River of Missouri? From the mouth of Platte River to a point in Grand River of equal altitude to the Missouri at Leavenworth is considerably shorter than to the latter point. It is quite possible that Grand River was not much higher in preglacial time than now. The region has not been examined with reference to this problem, but there is nothing in the course of present streams nor anything reported concerning the geology of that region which suggests that the Platte ever followed that course. We must therefore leave the problem not definitely solved, though the second hypothesis seems on the whole the more probable.

8. *Kansas River*.—The preglacial course of this stream is known to have followed nearly its present course but from 125 to 150 feet higher than now. This is shown by stretches of chert gravels with no admixture of northern erratics, such as the glaciers brought into the region. We may conceive that it followed the course of the Missouri from Kansas City to the vicinity of Miami and thence southeast by Salt Fork to the Lamine River and back to the Missouri again. If the Platte reached Grand River it would here have joined the Kansas.

From the distribution of the drift and loess in Missouri I argued some years ago[5] that the Osage in early Pleistocene did not join the Gasconade but turned north by the present course of Auxvasse Creek and over into Salt River and so to the Mississippi. It does not seem very probable, though not clearly forbidden by known facts. The upland between rises to 870, and there is no trace of divide between the Osage and the Gasconade, nor are they different in depth and age, as we should expect, if they had been separated till recently. The other alternative is to suppose that its course was down the present Missouri to its mouth, and that the shallow valley along the line of the Auxvasse and Salt Fork is due to general erosion acting on softer rocks, rather than to the presence of a master stream.

[4] *Kan. Univ. Sci. Bull.*, Vol. VI., p. 375.

[5] Mo. Geol. Survey, Vol. X., pp. 200 and 212.

B. THE MISSOURI DURING THE NEBRASKAN STAGE

We now proceed to consider the probable history of the Missouri during the successive stages of the Ice Sheet of the Pleistocene. The stages usually recognized are in order: Nebraskan, Kansan, Illinoian, Iowan and Wisconsin, with substages of the last Altamont, Gary Antelope, etc., corresponding to the principal moraines left.

We know little of the Nebraskan Stage except that the ice did not then extend so far as the Kansan and that its deposits have been mostly carried away or hidden by the ice of the latter stage. The ice advancing from the north gradually pressed southward up the Red River valley, and dammed the master stream, formed of the streams we have enumerated as flowing northeast from the present James River valley, and caused an overflow into the Des Moines valley. Later it closed up their entrance into the Red River valley from the west, and caused the Missouri, Cannon Ball, Grand and Cheyenne to become a lake, and to overflow whatever divide separated them from White River, and eventually to overflow the divide separating them from the Niobrara, outlining for the first time the course of the James River.

Meanwhile, the ice passed more freely southward in the Des Moines valley, filling it and forcing the Niobrara to overflow what ever divide separated it from the

Platte, and compelling all the streams mentioned to find their way around the edge of the ice southward, probably along the line of the present Missouri, or a little west of it, from Sioux City to Nebraska City and quite likely for a time through the Grand River of Missouri.

We are assured that the ice entered eastern Nebraska and reached to the south line of Iowa. In Dakota, it probably did not enter the James River valley extensively, for the gap by which it entered was probably narrow and its axis at right angles to the lobe which filled the Red River and Des Moines valleys.

C. THE MISSOURI DURING THE KANSAN STAGE

After a recession, we know not how far back, the ice advanced again to its maximum extent. The ice filled the Des Moines valley again, and overflowed southward to central Missouri, westward to Lincoln, Neb., and southwest to Topeka, Kan. As it crowded the great stream which skirted its edge, for the first time it overflowed the divide separating it from the Kansas, at Weston, Mo., a little north of Leavenworth. This fact is recorded in a stratum of boulders, nearly 20 feet thick and extending for miles along the bluffs east of the river. It rests on Carboniferous shales which rise about 140 feet above the present river. Among the boulders are scattering ones of northern origin attesting the vicinity of the ice sheet. Of course, when the ice reached Topeka, that locality of Weston was deeply buried with ice, and the master stream was forced much farther westward, as we shall see.

Meanwhile, the lobe entering the James River valley found, no doubt, a freer access because of the erosive work of the earlier ice lobe and of the streams attending it, for they worked on soft material. The latter must have been quite large, for they drained the western edge of the ice quite extensively. Besides, the head of the ice behind was probably higher than before and the push forward stronger. Moreover, because of the latter condition, the ice overrode the divide to the north more, and the push was more southward than before, so that in this Kansan stage the Dakota ice lobe reached perhaps as far south and west as West Point, Neb., and became confluent with the west edge of the Minnesota-Des Moines lobe for hundreds of miles.

As the ice advanced in the James River valley the surrounding streams had to shift laterally westward and when dammed rose and overflowed local divides, working their way southward around the ice. The Missouri River entering the James River valley from the north, probably with the Souris, skirted the western edge of the ice, through the Dakotas to the Niobrara, being successively augmented by the various streams before mentioned from the west. Reaching the Niobrara it first followed it eastward to the vicinity of Sioux City, but later as the Dakota lobe crowded against the highlands of northeastern Nebraska, the river was choked off and, being dammed, it formed a deep lake, reaching far north along the western edge of the ice and eventually overflowed southward from the south bend of the Niobrara, past Creighton and Plainview, where the channel is still traceable, to the Elkhorn.

So also farther south, the stream was pushed westward by the advance of the Kansan ice from the former course along the east line of Nebraska, to a line along Logan, Elkhorn and Platte rivers, and possibly for a short time over the divide into the Nemaha to its earlier course through Missouri.

But eventually when the ice reached its maximum, the stream from the Niobrara before sketched crossed the line of the Elk-

horn at Norfolk, went up Taylor Creek, over the divide south at Creston, to the Platte, and over the divide south of that, near or east of David City, into the Big Blue. From there the course is clear.

The course from the Elkhorn to the Big Blue is largely conjectural. There may have been no distinct channel much of the way, for any considerable time. Drift deposits in Nebraska seem more than usually of a stratified or banded character especially toward the margin. There may have been extensive shallow lakes over much of the way.

Some present altitudes along this course will be instructive. Through the Dakotas, the altitude may have been 1,600 to 1,700 feet; Plainview is 1,683, Norfolk, on the Elkhorn, 1,525; Creston, 1,604; Schuyler on the Platte, 1,350; David City, 1,607; Millerton, on the Big Blue, 1,590. It may possibly have reached the Big Blue by Skull Creek and Oak Creek passing a little west of Lincoln and over the divide near Berks, without finding an altitude over 1,500 A. T.

After reaching the Big Blue the course was clear. The course was unobstructed to the Kansas at Manhattan, Kan., and eastward by the latter stream around the ice to the Mississippi. So at first, but as the ice continued southward it for a time dammed the Big Blue, a little below Blue Rapids, Kan., forming a short-lived lake which covered the eastern half of Washington county, Kan., and possibly at about the same time formed a similar lake, Kaw Lake as it has been called, in the valley of Kansas River, by filling the trough of that stream with ice from Wamego to Lecompton, a distance of more than sixty miles. Kaw Lake, soon filled and found an outlet over the divide south 200 feet higher than the present stream, and from the valley of one small tributary of the Kansas to another, till southeast of Topeka it reached the valley of the Wakarusa, which conveyed it around to the valley of the Kansas below the barrier. At Kansas City the ice sheet crowded against the heavy limestone ledges in the northern part of the city, while the river occupied the valley in the southern part of the city, which leads eastward to the Missouri again.

This course was occupied through Kansas long enough to cut down quite a channel and to pave it with boulders and gravel, before the recession of the ice opened up the channel of the Kansas again.

D. WHILE THE KANSAN ICE WAS RECEDING

Though the ice sheet of the Kansan stage seems not to have paused in any one position long enough to form a marginal moraine anywhere, its advance and recession must have been very slow. After the Kansas resumed its preglacial course it cut down considerably before it ceased to receive the drainage of the ice, or before main drainage of the ice had shifted back to the line of the present Missouri, south of Dakota.

Omitting many details that might be given in the progress of shifting, I will simply give one which has been studied.

When the Kansan ice was at its maximum, the master stream of drainage flowed past Plainview at an altitude of 1,683. As the ice receded to the east and north the stream found a way at a lower level along the edge of the ice for several miles and then over the divide at Coleridge at 1,552, and then down Logan Creek. This allowed the rapid lowering of the water in the temporary lake in the Niobrara, and caused the deposition of much gravel along the line. As the ice receded farther the stream followed the ice front till it reached the line of the former course of the Niobrara, which passed northeast from its present

junction with the Missouri and joined the James several miles north of Yankton.[6]

At this point we may offer a word concerning the loess. This problematic deposit covers the Kansan till almost universally. The surface of the latter is generally much eroded, and because of this it has been argued that a long time elapsed between the deposition of the two formations. It was once claimed that the loess was largely of Iowan age, but it can be reasonably questioned whether erosion might not have been rapidly accomplished by the waters closely attending the edge of the ice, while the loess may have been deposited in flooded streams and local lakes remote from the edge. This silty material has doubtless been further modified by wind action and by later erosion and slumping. A strong objection to the flood theory, formerly felt, was the supposition that the channels of that time were as deep as the present, which we have seen was not the case. The drainage level of Kansan time was from 80 to 120 feet higher than that of the present, and it would have required scarcely a higher rise of water to have overflowed the uplands of that time than that which we shall find attended the retreat of the Wisconsin ice sheet.

E. FROM THE END OF THE KANSAN STAGE TO THE BEGINNING OF THE WISCONSIN

This was a long time during which the ice occupation of the region under consideration was not conspicuous. It corresponds to the Illinoian and Iowan advances and secessions of the ice. Elsewhere the ice found a growth into southern Illinois and far enough into southeastern Iowa to push the Mississippi westward nearly forty miles, then a recession and an advance from the northwest in eastern Iowa till the Mississippi was pushed eastward over into Rock River.

Meanwhile the ice may have lingered in northern Minnesota and Dakota and have caused greater volume to the streams than now. The course of the master stream was doubtless in the James valley approximately along the course of the present James River, and further south along the present Missouri. Erosion deepened all channels, till their bottoms approached the level of the present surfaces of the streams. The valleys were widened considerably, particularly in the soft Cretaceous formations in the Dakotas and northwestern Iowa.

F. DURING THE ADVANCE OF THE WISCONSIN ICE

As in earlier stages the Minnesota and Dakota lobes of ice were the only ones advanced southward along the same lines which affected seriously the Missouri. They advanced southward along the same lines as before, and though probably with greater velocity and vigor, yet they did not attain so great extent. This may be explained possibly by a warmer climate than in former advances. The Minnesota lobe reached only to Des Moines, Iowa. The Dakota lobe only to the south line of South Dakota, although it pushed farther westward than before up the valleys of the western tributaries. Why this should be is not very evident. Possibly because of the greater depth and width of the trough of the Niobrara River where it was transverse to the paths of the ice, and because of the greater volume of water skirting the ice front there on the south. On the west, however, the greater maturity and therefore the greater width of the valleys of the western tributaries, like the White, Cheyenne and Grand, enabled the ice to push westward easier than before. At any rate the de-

[6] *Bull. G. S. A.*, Vol. 23, pp. 463–470.

posits, moraines and till, show that the ice pushed westward up each of the valleys nearly to the line of the present Missouri. In other words, the ice filled the present James River valley so completely that all the western streams were dammed and the waters rose in each till an outlet was found southward. Between the Missouri and Cannon Ball and Grand rivers the divides were low and of soft material. But between the Grand and the Cheyenne was a prominent ridge capped with Fox Hills sandstone rising over 2,000 A. T. North of this was formed Lake Arikaree, reaching up the line of the present line of the Missouri to or beyond the mouth of the Yellowstone. Into it at several points the ice sheet at its maximum dropped small icebergs, by which boulders were scattered over the bed of the lake, and particularly on its southern margin, which is now in places marked by a line of boulder-capped buttes and ridges apparently corresponding to an old water level or lake margin.

The divide between the Cheyenne and White rivers was again comparatively low, but that between White and the Niobrara was again high, nearly 2,000 feet A. T., and capped with Tertiary sandstone. Through this an outlet was started which now is an imposing gorge, 750 feet deep. The ice also blocked the Niobrara from Springfield to Yankton, but did not force it over the divide southward as during the Kansan stage. Instead the river was crowded up on the south side of its valley where it excavated so deep a channel before the retirement of the ice that it became permanent.

So we have the present course of the Missouri from Ft. Stevenson to Yankton as a direct result of the Wisconsin stage of the ice sheet, as the course from Sioux City to Nebraska City was probably determined by the Nebraskan stage and from Nebraska City to Kansas City and possibly to its mouth by the Kansan stage.

G. DURING THE RECESSION OF THE WISCONSIN STAGE

The Wisconsin was the last great invasion of the ice sheet, and its recession was long and marked by long pauses, when belts of knobs and ridges of débris were dropped from the nearly stationary edge of the ice. The first of these and the most voluminous was formed a few miles within the maximum extent of the ice. Before the next was formed there was recession far within the line of the second moraine and then an advance and a pause to form the second moraine. So that the Wisconsin stage had many substages similar to the stages already reviewed except that they were shorter and with ever-waning extent. During the recession from the first moraine there was the unloosing of great volumes of water as there was at the close of the Kansan, laden with much sediment, coarse and fine. The coarse dropped near the edge of the ice-formed valley trains, the fine, carried far, formed a deep accumulation of silt, particularly in broader and stiller portions of the streams. Such deep deposits are found well-preserved at many points. Their upper surface seems originally to have been nearly flat like a river terrace, but is now not only deeply eroded, but is more or less increased in height by the wash from the upland back. The lower limit is of course uneven, but usually is only a few feet above the present level of the streams. This deep silt and sand deposit is frequently from 80 to 120 feet deep. It closely resembles the loess often found on the uplands in the vicinity. In fact they have often been confused, nor is it any wonder.

This lower loess or early Wisconsin flood deposit is finely exposed at Kansas City,

Kan., also in the bench along the north side of Kansas City, Missouri. At Leavenworth, St. Joseph, and south part of Sioux City, besides several less conspicuous points between, and further down the river. Similar deposits are found in the lower part of the Kansas River near Edwardsville, Holliday and Bonner Springs. Here it is due to back water from the Missouri, and the character and color differ from those of the Missouri River deposit.

After considerable examination I have no doubt that the similar terraces in western Iowa along the streams which headed near the edge of the Wisconsin ice are to be referred to the same cause. I refer to the terraces on the Boyer, Soldier and Maple. The absence of such along Mosquito, Nishnabotna and Nodaway confirms this conclusion. They were too far away to share in the floods from the Wisconsin ice.

Similar floods may have attended similar recessions from later moraines, but they were less effective, and after the third or fourth the ice retired too far away to affect the Missouri notably. Numerous lower terraces are found along the Missouri and its tributaries, which record such stages which attended the gradual deepening of their channels in the 15,000 or 60,000 years since.

In the recession of the ice, glacial lakes were formed from time to time. Lake Dakota was formed in the central part of the James River valley, while the fourth moraine was forming. It became nearly filled with a fine silt closely resembling loess.[7] Later Lake Agassiz occupied the Red River valley, but it was beyond the scope of our subject.

I leave the subject with you. If I have made any point clearer or suggested a thought which may lead to further light I shall be well satisfied.

It may gratify our national pride a little to see how cleverly nature, not long ago, changed so much of the drainage which was sweeping the rich soil of our great plains into the British dominions, so that it was permanently diverted into our borders.

From this sketch, we see how nature has wrought the course and character of the greatest stream on earth, and one of the most important. It may not be called as historic as others, for its history is yet to come. Who can doubt that it is destined to be associated with some of the mightiest and most far-reaching events of the future,

J. E. Todd

University of Kansas

[7] *Iowa Acad. Sci.*, Vol. XIII., p. 187.

BENJAMIN OSGOOD PEIRCE

The death of Professor Benjamin Osgood Peirce at Cambridge on January 14 removes before his time one of the most valued members of the Harvard faculty and one of the most scholarly of American physicists. Having been asked by the editor of Science to contribute an obituary note, although feeling that one of his colleagues could do it in a more accurate manner, I could not forego the melancholy satisfaction of paying a personal tribute to the best of teachers and the cherished friend of thirty years. Peirce came to Harvard as instructor in the same year as the writer as a freshman, and the admiration he then inspired has only grown with years.

Peirce's first ancestor in America was Richard Norman, who came to Gloucester in 1623. His great-grandfather, Benjamin Peirce, was killed at Lexington. From him was also descended Benjamin Peirce, the distinguished mathematician. On his mother's side Peirce was descended from ship-owners in Salem. Born on February 11, 1854, at Beverly, it was from such sterling stock that Peirce inherited the New England conscience and capacity for thoroughness which were his leading characteristics. He received an excellent preliminary education in the schools of Beverly, and afterwards prepared himself for college, with plenty of Latin, Greek and mathe-

matics, then, as now the best training for a scientist, and he never forgot them. Neither did he slight the modern languages nor the vernacular, for nothing but the best of English ever proceeded from his mouth or pen.

Graduating at Harvard in 1876, he had already shown a marked talent for both mathematics and physics, and, receiving a traveling fellowship, he proceeded for further study to Leipzig, where he worked in Wiedemann's laboratory, and obtained the degree of Ph.D. in 1879. After this he spent another year at Berlin with Helmholtz, from whom he drew much inspiration. During these four years he had not only obtained skill in experimental research, but he had obtained a thorough grounding in the principles of mathematical physics, then almost entirely untaught in any American university.

Returning to the United States in 1880, Peirce spent a year in teaching at the Boston Latin school, and in 1881 received the appointment of instructor in mathematics at Harvard. This was not what he desired most, but he took hold of the work with enthusiasm, and among other subjects taught the calculus in a two-years' course, alternating with Professor Byerly. A splendid course it was, and those students who took it under one disputed with those taking it under the other as to which was the better teacher. But the most notable course instituted by Peirce and shared by this pair of masterly teachers was that one in which Peirce treated the theory of the Newtonian potential function, and Byerly the theory of Fourier's series. The writer well remembers his feeling of mystification, when at the end of his freshman year, on consulting the elective pamphlet to select courses for the next year, he came across the announcement, Arbitrary Functions and the Theory of the Potential. What on earth were arbitrary functions, and what was the "potential"? His highly respected teacher in the high school, hitherto an unfailing adviser, could not tell. But as a matter of fact this course marked a new era in American university work, for, as has been stated above, the teaching of mathematical physics in this country was practically non-existent. I say this advisedly, having in mind that mechanics was taught to a certain extent, and that there were one or two courses on the theory of light, but the character of the teaching was totally different from that of the present era. Peirce had come back from Germany full of enthusiasm for the thoroughgoing German methods and the magnificent achievements of Gauss, Riemann and Dirichlet, which had opened up to him a new world. The backbone of theoretical physics is the subject of partial differential equations, and the most suitable gate to enter by is the theory of the potential belonging to forces acting according to the law of the inverse square. This Peirce had the insight to perceive, and made it his part to work up a course on this subject, which he treated with rare clearness and skill. The subject-matter of this course afterwards appeared in his treatise "Elements of the Theory of the Newtonian Potential Function," which passed through three or four editions and constituted a model of what such a work should be. One other of the fruits of his teaching was the short table of integrals, whose convenience has brought him the gratitude of many a student of the calculus.

In 1884 came the appointment as assistant professor of mathematics and physics, and Peirce took his place in the department of physics, to which he rightly belonged, and in which he was able to do his share in the reconstitution and modernization of that department which it was now to undergo in the new Jefferson laboratory. This was at the beginning of systematic laboratory work in physics in this country, and there was a certain amount of friction in getting the new ideas started. In 1888 with the retirement of Professor Joseph Lovering he was succeeded by Peirce in the Hollis professorship of mathematics and natural philosophy, a decided honor for so young a man. At the same time Professor John Trowbridge became director of the laboratory, and from this time on there was a rapid development of the laboratory work into what has become one of the best organized courses in the country, while re-

search was for the first time recognized and encouraged. Peirce took for his field the development of the laboratory course in electricity and magnetism, which he brought to a high degree of efficiency and interest. At the same time he devoted a large part of his powers to the graduate courses on mathematical physics, particularly the theory of electricity and magnetism and hydrodynamics. Besides this he threw himself vigorously into the prosecution of research, which he kept up with unabated assiduity until the end. Without going into these researches in detail, it will suffice to say that they were probably about fifty in number, and of considerable variety. Beside those on various subjects of mathematical physics, the experimental papers nearly all required an unusual amount of mathematical theory. Most notable are the researches on the thermal conductivity of various kinds of stone and its variation with temperature, in which he had the collaboration of his friend R. W. Willson, and his researches on magnetism, on which he was still engaged at the time of his death. Both these subjects are of extreme difficulty, and to them he devoted his best efforts, combining remarkable experimental skill with the mathematical knowledge necessary for their treatment. It was this rare combination that characterized the success of Peirce's work, and made him such a valuable colleague. It was said by one of his colleagues that he knew more physics than any other member of the department of physics, and more mathematics than any other member of the mathematical department, and the statement was not contradicted by any of them.

But this devotion to work, while producing most satisfactory results, was not without its penalty, for the inevitable result of overwork was a nervous breakdown, to which he was obliged to give way nearly a dozen years ago, and to take the much-needed year of rest in Europe. Unfortunately it was too late, and one year was not enough. Although he recovered sufficiently to resume his work, eventually at his normal pace, he really never recovered, and the rest of his life was a brave fight against ill-health, carried on against tremendous odds, with a cheerfulness which deceived many. For years he suffered from insomnia, and at last the mechanism was entirely worn out, and after an extremely painful illness borne with great fortitude he succumbed to an attack of angina pectoris.

But it was not alone his scientific work that made Peirce such a source of strength to the university, it was the influence of his rare personality that drew to him hosts of friends among students and colleagues. Absolute self-abnegation and devotion to duty were the keynote of his character. With him modesty was so excessive as to almost cease to be a virtue. When consulted by a colleague with regard to some difficulty, almost invariably his first response was that he did not know anything about the subject, and it was necessary to draw him out with insistence in order to get at his superior knowledge. He was always fearful of giving trouble to some one, and frequently lay awake at night worrying over the troubles of others, never his own. Always cheerful and ready with a joke or anecdote, he was the kindest and sanest of advisers. Possessed of a sure and childlike religious faith, he was almost a Puritan in the conduct of his own life, but absolutely sympathetic and charitable toward others. Only himself he did not spare. Often his friends would remonstrate with him against his risking his health by overwork, but it was impossible to get him to desist. His teaching was characterized by the greatest clearness and infinite pains. Everything that he did was done with elegance and neatness. Often the writer has marveled to see the beautiful drawings that he made to illustrate his papers, the curves being laboriously cut out in zinc for greater accuracy. He kept a font of mathematical type in the laboratory, and set up many of the complicated formulæ in his table of integrals with his own hand. Though a thorough Yankee, he had a broad knowledge of Europe, spending much time in England and Scotland, and never forgetting his precious years in Germany. He was a great reader, and was extremely well informed

on a wide range of subjects, never giving up his interest in the classics. In every way Peirce was a living example of that breadth of character and interest which has so often been characteristic of great scientists, but which the specialist is so commonly supposed to lack.

Peirce's scientific activity was rewarded with many distinctions. In 1906 he was elected a member of the National Academy of Sciences. He was also a fellow of the American Academy of Arts and Sciences and of the American Philosophical Society, member of the American Mathematical and American Physical Societies, of the Astronomical and Astrophysical Society of America, the Société Française de Physique, and the Circolo Matematico di Palermo. He was one of the founders of the American Physical Society, and was last year elected its president. The election would have been renewed this year, but just before the meeting Peirce, evidently feeling his inability to discharge the duties of the office, had a notice sent out urging members not to vote for him. Unfortunately his misgivings were justified. In 1910 Harvard conferred upon him the degree of Doctor of Science.

Professor Peirce married, on July 27, 1882, at Edinburgh, Scotland, Miss Isabella Turnbull Landreth, by whom, with two daughters, he is survived. At his funeral Appleton chapel was crowded with colleagues and students, but the number of friends who will never forget his influence is far greater than could be contained in any building.

Arthur Gordon Webster

THE BRYANT WALKER EXPEDITION, OF THE UNIVERSITY OF MICHIGAN, TO THE SANTA MARTA MOUNTAINS, COLOMBIA, IN THE SUMMER OF 1913

This expedition, sent out from the museum of zoology, was organized to do zoological work in and about the west end of the Sierra Nevada de Santa Marta, in northeastern Colombia. The plan of the work was that adopted for all expeditions sent by the museum to regions outside of the state of Michigan. Relatively small areas where a variety of conditions prevailed were located, and these were examined for those groups of animals to which the members of the museum staff are giving most attention. Particular study was made of the habits and local distribution of the species, and the results were preserved as specimens, notes and photographs of specimens and environments.

The party consisted of A. S. Pearse, of the University of Wisconsin, F. M. Gaige, of the University of Michigan, and the writer (in charge); and the groups which received most attention were the reptiles, amphibians, ants, crustaceans and molluscs. The collections of these forms may be summarized as follows: reptiles and amphibians, about 1,000 specimens; ants, 603 lots; crustaceans, 140 lots; molluscs, 150 lots. Small collections of other groups were made by preserving such material as was discovered, the collecting being restricted to a few forms which could be secured in series without interfering with the regular work. The groups which received such attention are leeches, earthworms, myriapods, scorpions, beetles, the genus *Peripatus*, and fishes. The other material secured consists almost entirely of specimens of those forms needed for illustrative purposes or as additions to the synoptic collections in the museum.

The expedition reached Santa Marta on July 1 and at once proceeded to an elevation of 4,500 feet. From this point a strip of territory from 2,200 feet to 8,300 feet (the summit of San Lorenzo) was explored for twenty-six days. On July 27 the party moved to the plain and spent nine days in continuing the explored strip from 2,200 feet to the foot of the range. The remainder of the time until September 1 was given to the investigation of the lowlands in three places—about Santa Marta, at Fundacion and on the Salamanca coast near Cienaga.

Not a little of the success of the expedition is to be attributed to the assistance and hospitality of Mr. and Mrs. O. L. Flye and the members of their family, Mr. and Mrs. M. A. Carriker, Mr. William A. Trout, consular agent

at Santa Marta, and Mr. Robert Sargent, Americans residing near Santa Marta. Through their efforts the party was provided with splendid facilities for field work and received substantial assistance in gathering material. The Colombian government permitted the free entrance of the equipment.

The collections of the expedition are now being studied by a number of investigators, and the results will be published from time to time as the studies are completed.

Alexander G. Ruthven
Museum of Zoology,
University of Michigan

THE PRESIDENT OF THE UNIVERSITY OF ILLINOIS

A correspondent at the University of Illinois asks us to print the following communication:

In order to ascertain whether or not a persistent rumor that he had not the support of the faculty, was true, President Edmund J. James, of the University of Illinois, submitted the matter to a referendum vote of those of the faculty elected for two years or longer. The result was overwhelmingly against the rumor—188 expressing confidence in the president as against four who voted in the negative. At a later meeting a vote of instructors and assistants—those holding positions of one year tenure—revealed an even greater degree of confidence, but one disenting voice arising. The latter meeting was called on the initiative of the men themselves.

The procedure was unique in American universities. Indeed the American university system has been criticized to the effect that the president or head has the power of an autocrat. Autocratic power, all history shows, is unsafe in any man's hands, as it soon becomes too dear to his heart. Therefore when a man elected to the presidency of a great university voluntarily submits the question of his own efficiency to the vote—a secret ballot—of his force, the act has signal significance.

During the ten years that Dr. James has served as president the university has made phenomenal growth in revenue, equipment, faculty, attendance and general standing. The commonwealth has been liberal; trustees, members of the faculty, alumni and other friends of the university have cooperated heartily in bringing about this result. The president felt, naturally, that he also had been a factor in this upbuilding, that unless this was so after ten years of persistent and laborious work, his presence in such an institution as its head was a mistake. As a consequence he submitted the following to a referendum vote of the faculty: "I want to know whether in your opinion my administration as president of the University of Illinois during the past ten years has been liberal and progressive, and has promoted the substantial development of the institution on broad and scholarly lines, and whether as president I have the regard and cooperation of the faculty. On this proposition I ask you to vote either yes or no."

The result on a secret ballot was, as stated above, 188 to 4, in favor of confidence in the president.

Previous to this endorsement by the faculty the Illini Club of Chicago, consisting of 1,000 graduates, had expressed to the president their most unqualified approval in a set of resolutions passed at its annual business meeting.

Following this the pastors of some nineteen churches in the twin cities of Urbana-Champaign, including the Y. M. C. A.'s, Methodists, Catholics, and practically all denominations represented in the cities, sent a special delegation bearing a series of signed resolutions to President James expressing their confidence in him and their pleasure in the many evidences of the university's progress.

Still later the Alumnæ Association of Chicago addressed a letter to President James saying among other things. "It is the earnest hope and wish of every member that you continue to serve as president in the work which has made possible the constant growth, the increasing influence and the general development of the University of Illinois."

THE CARNEGIE INSTITUTION EXPOSITION TO TORRES STRAITS

The expedition of the department of marine biology of the Carnegie Institution of Washington has returned from the region of Torres Straits where it visited the islands between New Guinea and Cape York, Australia, remaining for the greater part of the time upon Maer Island, one of the Murray Islands, on the outer edge of the Great Barrier Reef south of the Bligh Entrance.

In response to Ambassador Bryce's letters of introduction the Governor of Queensland and

of New Guinea received the members of the expedition with a courtesy and kindness which contributed materially to its success.

The expedition was under the leadership of Dr. Alfred G. Mayer, with whom were associated Dr. Hubert Lyman Clark, of Harvard, Dr. E. Newton Harvey, of Princeton, Frank A. Potts, of Cambridge University, Professor D. H. Tennent, of Bryn Mawr College, and Mr. E. M. Grosse, of Sydney, whose excellent colored drawings served to illustrate the living aspects of the echinoderms which were collected by Dr. Clark.

The expedition was well equipped with apparatus and provided with a naptha launch, Mr. John Mills, of the department of marine biology, being the engineer.

For littoral echinoderms there is probably no richer region in the world than that of the Murray Islands, lying as they do about 70 miles south of New Guinea and within 6 miles of the outer line of the Great Barrier Reef of Australia. At Maer Island alone Dr. Clark collected about 150 species of echinoderms, and about 100 of these were beautifully figured by Mr. Grosse. Clark also found that crinoids are more active than has been generally supposed, some species being able to swim actively through the water.

Professor Tennent succeeded in effecting a cross between a male crinoid and the echini, and at Badu Island he obtained abundant material upon echinoderm crosses for an extensive cytological study.

Dr. Harvey found a holothurian, certain living pigments of which change purple in alkalis and red in acids, and he was thus enabled to determine the relation between the rate of penetration and the degree of dissociation of electrolytes.

Mr. Potts conducted several interesting ecological studies upon the habits of crustacea, and Dr. Mayer made an intensive study of the coral reefs, discovering that temperature is a factor of primary importance in determining the growth of corals. Those corals which are most resistant to high temperatures are those which are best able to withstand being buried beneath the mud, and this suggests that high temperature produces death by asphyxiation.

Certain coral beds at Thursday Island, Cape York, Australia, which were measured and photographed by Saville-Kent in 1890 were remeasured in 1913 and species of Porites and Symphyllia were found to have grown in diameter at an average rate of 1.8 to 1.98 inches per annum, or about 44 inches in 23 years.

The health of the members of the expedition was good throughout the period of their investigations, and some interesting papers may be expected to be published by the Carnegie Institution of Washington as a result of their studies.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES RICHET, professor of physiology at the University of Paris, has been elected a member of the section of medicine and surgery of the Paris Academy of Sciences to replace the late Dr. Lucas-Championnière.

PROFESSOR L. MANOUVRIER, Paris; Professor Karl von den Steinen, Berlin; Dr. Alfred P. Maudslay, London; his Excellency W. Radloff, St. Petersburg, and Professor Émile Cartailhac, Toulouse, have been elected to honorary membership in the American Anthropological Association.

DR. CARL HUGO KRONECKER, professor of physiology at Berne, celebrated his seventy-fifth birthday on January 27.

OFFICERS of the Cincinnati Research Society have been elected as follows: *President,* Dr. Oscar Berghausen; *Vice-president,* Dr. E. R. Remelin; *Secretary,* Dr. J. L. Tuechter; *Executive Committee,* Dr. H. McE. Knower and Dr. Charles Goosman.

THE Syracuse chapter of Sigma Xi has initiated as non-resident members: Dr. Robert S. Breed and Dr. Ulysses P. Hedrick, of the New York Agricultural Experiment Station, and Dr. William J. Miller, of Hamilton College.

PROFESSOR C. E. SHERMAN, of the civil engineering department of the Ohio State University, has undertaken a complete examination on the summit level of the Ohio canal through

Akron, with a view to determining the availability of its waters for steam, sanitary, water supply power, and such other purposes as may be found advisable.

Dr. Georg Aulmann, assistant in the Royal Zoological Museum at Berlin, has been called to the directorship of the Natural History Museum at Düsseldorf.

Professor H. T. Barnes, of McGill University, lectured before a general meeting of the New York Academy of Sciences on February 16, his subject being "The Physical Effects Produced by Icebergs in the North Atlantic."

The Society for Biological Research of the University of Pittsburgh held its first open meeting of the year 1913–14, on January 29, at which time Dr. Ross G. Harrison, of Yale University, addressed the society on "The Life of Tissues Outside the Organism."

Dr. Joseph Jastrow, professor of psychology in the University of Wisconsin, gave the opening convocation address at the University of Missouri on February 4, on "Theory and Practise."

Dr. Charles Sedgwick Minot, of Harvard University, made one of the addresses at the thirty-second annual banquet of the faculty and students of McGill University.

The next convocation orator at the University of Chicago will be Professor James Rowland Angell, head of the department of psychology and dean of the faculties of arts, literature and science in the university.

Dr. Wolfgang Ostwald, of the University of Leipzig, has delivered at the University of Chicago a series of five lectures on the subject of "Colloidal Chemistry."

Professor Vladimir Karapetoff, of the electrical department of Cornell University, has returned from a trip to Washington, D. C., where he delivered four two-hour lectures before the engineer officers of the United States Army, Washington Barracks. The lectures were given on February 5, 6 and 7, and the subjects treated were "Alternating Currents," "Theory of Electrical Machinery," "Design of Electrical Machinery," and "The Fundamentals of the Magnetic Circuit." Lieutenant Atkisson, who is in charge of electrical and mechanical engineering, and his assistant, Lieutenant Lampert, are former students of Professor Karapetoff's at Cornell.

The Mendelian Society of Vienna has celebrated the thirtieth anniversary of Mendel's death by opening a new institute devoted to research in heredity.

Dr. Roswell Park, professor of surgery at the University of Buffalo, a distinguished surgeon and scientific author, died suddenly on February 15, aged sixty-two years.

Dr. Albert Charles Lewis Gotthilf Günther, late keeper of zoology in the British Museum (Natural History), distinguished for his contributions to zoology, especially for his work on fishes, died on February 1 at his residence at Kew Gardens, in his eighty-fourth year.

Dr. Eduard Huber, professor of Indo-Chinese philology in the French School at Hanoi, has died at the age of thirty-four years, while engaged in an expedition to Cochin China.

Dr. Fritz Jummersbach, professor of agriculture at Munich, has died at the age of fifty-six years.

Dr. Karl Albert Neufeld, of the University of Würzburg, assistant director of the food laboratory, has died at the age of forty-eight years.

The U. S. Civil Service Commission announces an examination for technical assistant in malaria investigations to fill vacancies in this position in the Public Health Service, for duty in the field, at entrance salaries ranging from $1,800 to $2,200 a year. The duties of this position will be to conduct laboratory studies of malaria, to make surveys of malarial regions, and to advise in respect to the prevention of the disease. It is desired to secure persons thoroughly competent to make thick and thin blood smears, stain the same and identify the plasmodium of malaria in all its stages in such preparations.

The U. S. Civil Service Commission also announces an examination for geologic aid and assistant geologist, for both men and wo-

men, on March 11–12, 1914, to fill vacancies as they may ocur in these positions in the U. S. Geological Survey, at salaries ranging from $60 a month when actually employed to $1,500 a year.

COMPETITIVE examinations for the position of sanitary supervisor, New York State Department of Health, will be held in various cities throughout the state, on March 7, 1914. Open to men and women. Application blanks must be filed in the office of the civil service commission on or before March 2, 1914. The following conditions are prescribed for candidates: (1) They shall be physicians. (2) They shall when appointed be not less than twenty-eight nor more than sixty years of age. (3) They shall either (*a*) have served as a health officer of a city, town or village having a population of not less than 3,000 persons, for a period of at least four years; or (*b*) shall have received instruction approved by the Public Health Council, or a duly authorized committee thereof, in sanitary science, including five hours' instruction per week during the school year, in an educational institution, and shall have had at least two years' experience in public health work; or (*c*) shall have received a degree, certificate or diploma in public health granted after the completion of a course approved by the Public Health Council, in an educational institution, and at least one year's practical experience in public health work; or (*d*) shall have submitted proof satisfactory to the Public Health Council, or a duly authorized committee thereof, that they have actually engaged in some form of public health work for a period of at least two years. (4) They shall not be allowed to engage in the regular practise of medicine or in any other regular occupation or business; but they shall be at liberty to retain or accept other positions in public health work, such as local health officer, teaching public health and related subjects, or other kindred lines of work. The State Department of Health, however, retains the right to determine at any time whether the extent of such other work interferes with the proper performance of his duties as sanitary supervisor. The State Department of Health has fixed the salaries of sanitary supervisors at $4,000 per annum, each sanitary supervisor being required out of this sum to incur all expenditures for traveling expenses which may be necessary to enable him to efficiently perform his duties in all parts of his district.

A CONFERENCE will assemble in Rome on February 24 and subsequent days to consider the question of an international convention for the control of plant diseases and the regulation of the importation of plants. It is described as a phytopathological conference, and is to be held at the International Institute of Agriculture. About fifteen countries are expected to be represented. Invitations were issued by the French government rather more than a year ago to a conference of this kind in connection with the general assembly of the International Agricultural Institute. In view, however, of the small number of acceptances received in time to arrange the meeting, the conference was postponed for a year.

THE Vienna correspondent of the *Journal of the American Medical Association* reports that by the bequest of $300,000 under the will of the late Professor Leegen, a former member of the Vienna medical faculty, the Academy of Sciences of Vienna has obtained means to erect a special institute for physiology. The idea is to devote the institute to scientific research solely; no beginners will be admitted, and the men working there will be appointed as whole-time officers, who may *not* devote their time to any other office—as teachers in universities or hospitals. Furthermore, the academy has obtained also the Vienna Biologic Institute, together with a handsome sum to keep it going, from its founders and present owners. From this institute emanated the biological discoveries by Drs. Kammerer and Pribram and now, in connection with the above-mentioned "Leegen institute," experimental physiology on a large scale, for purely scientific purposes, will be possible in Vienna, apart from the research going on in the university laboratories.

The errors of the noon and 10 P.M. time signals as sent out by the Naval Observatory during the month of January, 1914, were as follows:

January Day	Error Noon	Error 10 P.M.
1	—.04	—.04
2	—.03	—.03
3	+.01	——
4	+.01	+.02
5	+.04	+.04
6	+.07	+.05
7	+.07	+.06
8	.00	—.02
9	—.06	—.05
10	—.04	—.06
11	—.05	—.05
12	—.06	—.08
13	—.09	+.02
14	+.05	+.06
15	+.07	+.11
16	+.10	+.10
17	+.03	—.11
18	.00	—.03
19	.00	—.01
20	.00	—.03
21	—.01	—.01
22	—.03	—.03
23	—.03	—.06
24	—.00	+.04
25	+.04	+.07
26	+.05	+.07
27	+.11	+.07
28	+.05	+.04
29	+.07	+.09
30	—.23	+.14
31	+.16	+.19

The January number of the *Brooklyn Botanic Garden Record* contains a prospectus of courses to be offered by the Botanic Garden during 1914. There are 29 different courses, ranging from children's gardens and nature study to research work in plant physiology, mycology and plant pathology and genetics, and including courses in introductory botany, seven courses in household botany and horticulture, a course for the training of teachers of children's gardens, comprising nine different sub-courses, extending from January to October, and advanced botanical courses in plant pathology, fresh water microbiology, cytology, experimental evolution and phytogeography. In addition to the regular courses of instruction, there are also announced four courses of public lectures, two for children and two for adults, together with a statement of ways in which the Botanic Garden is prepared to cooperate with local schools in their botanical and nature study work. Classes in botany from high schools in Brooklyn are now using the equipment of the Botanic Garden, in some cases being taught at the Garden by their own teachers, and in other cases by members of the Garden staff, appointed especially for this work.

The city of Columbus and the State University have cooperated in the Columbus Horticultural Society, which is one of the oldest organizations of its kind in the United States, having been organized in 1845. The regular annual meeting was held in the new archeological and historical museum on the university campus, December 27, 1913. Professor William R. Lazenby was reelected president; H. Warren Phelps, vice-president; L. M. Montgomery, secretary; W. C. Mills, treasurer. The society has invested funds amounting to $6,000. It publishes a volume of its proceedings each year.

Some of the acacias, a group of trees with a world-circling range, are so valuable as a source of tannin and timber, says the Department of Agriculture in a bulletin recently issued, that their commercial cultivation in certain portions of the United States may prove profitable. Aside from their value for tannin and lumber, they are well adapted to the reclamation of sandy and semi-desert lands, some species being able to thrive with only three inches of rainfall. There are about 450 species of acacias, 300 of which are Australian species and the rest scattered over the world, principally in Asia, Africa and America. Australian acacias were introduced into California at about the same time the eucalypts were, and like the latter, have thrived there. Like the eucalypts they are not resistant to frost. At the present time the chief commercial value of acacias, says the department, seems to be for tanbark, although the tanbark species have important by-products. All of the leading tanbark acacias come from Australia, where they are generally known as wattles, from the fact that they were originally used for weaving and wattling the walls of huts. Actual tannin contents of the three principal tanbark acacias, as shown by analyses at the

University of California, are from 24 to 48 per cent. Oak and chestnut, the woods principally used in this country, yield from eight to thirteen per cent. of tannin. Acacia timber is beautiful in grain and durable in contact with the ground. Even the smaller species have a value for tool handles, furniture and various other useful and ornamental objects. Some of the best species yield a hard, heavy, close-grain, tough timber comparable to walnut and rosewood. In addition to tannin and timber, many of the acacias produce valuable by-products. The widely known gum arabic is derived principally from the Arabic acacia, though also from a number of Asiatic and African desert species. Cutch, an astringent gum in constant demand, is another acacia product. Many other kinds of gums are yielded by different acacia species. The flowers of still another species, known as cassie, yield a perfume, the manufacture of which at Grasse, France, the center of the perfume industry, is very profitable.

WE learn from the London *Times* that the plans of the Austrian Antarctic expedition, which it is hoped will sail from Trieste in the early summer, were set forth at a meeting held at Vienna on January 15. The principal supporter of the project is Count Hans Wilczek, to whose energies the success of the Austrian expedition which discovered Franz Josef's Land 40 years ago was largely due. Financial help is also being provided by the Academy of Sciences and the Geographical Society, but so far only about half of the required sum of over 600,000 kronen ($125,000) has been obtained. The leader of the expedition is Dr. Felix König, of Graz, who took part in the German Antarctic expedition. The ship which has been acquired is likewise that which was used in that expedition; her name, however, will be changed from *Deutschland* to *Oesterreich*. Dr. König, who is being assisted by the advice of Captain Amundsen, intends to sail from Trieste to Buenos Aires, and thence to South Georgia Island, where an intermediate station fitted with wireless telegraphic apparatus will be installed. By this means it is hoped to keep up communication between the ship, which will also be fitted with wireless, and civilization. The base is to be made close to a bay found by the German expedition in the newly discovered barrier, where it is hoped that the ship will be able to winter. The principal work will be carried out by sledge journeys, which will be made in three directions, one to the south with the object of reaching Queen Maud Mountains, the second towards Grahamland in order to try to discover its continuation southwards, and the third in the direction of the Enderby quadrant. The expedition is expected to cover two years, but provisions are being taken for three. From remarks made at the meeting by Professor Nordenskiöld the object of the expedition appears to be to discover the relations of the eastern and western section of the Antarctic regions with one another.

UNIVERSITY AND EDUCATIONAL NEWS

MRS. RUSSELL SAGE has extended her offer to give $100,000 for a new dining hall at Princeton University provided that the university raise $400,000 for the purpose.

UNDER the will of Dr. Cumberland George Herndon, two scholarships, named after the testator's father the William A. Herndon scholarships, have been founded in the department of medicine of the University of Virginia. Candidates must be unable to defray the expense of their medical education and must signify their intention of entering the medical service of the army or navy. The scholarships provide for the necessary expenses of the student during the four years of his course and will yield approximately $425–$450 per annum.

BY an agreement between the universities of St. Andrews and Bordeaux, Dr. T. Pettigrew Young, lecturer in French at St. Andrews, will proceed to Bordeaux to act as exchange professor for the month of May, while during the same period Professor Charles Cestre, of Bordeaux, will join the staff of St. Andrews University. Professor Cestre has also been commissioned by the French ministry of instruction to deliver a number of lectures on the French literature and language in various parts of Scotland and England.

A number of Herefordshire teachers came out on strike on January 31 owing to the refusal of the local education authority to establish a scale of salaries, whereby if a teacher's record is satisfactory his pay shall increase automatically until a maximum is reached. We learn from the London *Times* that the strikers include the head teachers of about 80 out of some 176 schools. In addition, there are schools where assistants and not the headmasters or mistresses are ceasing work. More resignations will fall due as the weeks pass, until at the end of March 117 head teachers out of 189 employed will be idle, and, including assistants, a total of 223. Before the teachers' threat to strike the average salary of headmasters was £111, against an average for all the British counties of £146 6s., and the average salary of head mistresses was £88 16s., against £100 8s. for the English counties. There were similar disproportions in the salaries of class teachers. The local education authority, admitting that the salaries paid in Herefordshire were low, increased the salaries of certain teachers in December last by amounts totalling £1,300 a year.

Dr. Ethelbert D. Warfield has resigned the presidency of Lafayette College.

Dr. George E. Brewer has been appointed to the chair of surgery at the College of Physicians and Surgeons of Columbia University. Dr. Walter B. James has asked to be relieved from membership in the medical faculty. He will retain his professorship and continue to direct research students from time to time.

J. F. McClendon, of Cornell Medical College, New York City, has accepted a position in the department of physiology, University of Minnesota Medical School.

Dr. Watson Marshall has been appointed demonstrator in laryngology in the School of Medicine of the University of Pittsburgh.

Dr. Marienne Plehn, assistant in the biological laboratory at Munich, has been made professor. She is said to be the fifth woman to receive this title in German universities.

Dr. August Brauer, director of the zoological museum of the University of Berlin, has been called to a professorship at Bonn, but it is expected that he will remain at Berlin.

DISCUSSION AND CORRESPONDENCE

THE CYTOLOGICAL TIME OF MUTATION IN TOBACCO

In the issue of Science for January 2, 1914, there is described a mutation that occurred in a variety of the common tobacco which gives promise to become of great economic value. In the article referred to it was assumed that the germinal change must have occurred after fertilization because the aberrant plant bred true. Professor Castle has asked if parthenogenesis may not be as reasonable an interpretation of the phenomenon since parthenogenesis is known to occur in *Nicotiana tabacum.*

The possibility had naturally occurred to us. And since it is impossible to prove a negative the same alternative may be presented in discussing any Angiosperm variation. Mrs. Rose Haig Thomas has reported parthenogenesis in *Nicotiana* and her work has been confirmed by Bateson on *one* variety.

One may not deny their conclusions, but the theorem of logic used above holds here as well. While admitting the possibility that Mrs. Thomas has found strains of parthenogenetic *Nicotiana,* it is possible that her results were incorrectly interpreted. We have made numerous attempts to secure parthenogenetic seeds from various species of *Nicotiana* without success. Dr. E. M. East and Mr. R. Wellington made nearly one thousand such attempts with over 50 species and varieties of the genus, also without success. We think it reasonable to assume, therefore, that parthenogenesis in *our* strain of *Nicotiana* is extremely improbable.

H. K. Hayes,
E. G. Beinhart

Connecticut Experiment Station,
New Haven

WINTER COLORATION OF WEASELS

To the Editor of Science: It is well known that throughout Canada, and in the northern parts of the United States, the weasels become white in winter, whereas in the southern, warmer parts of the country they do not do

so, but remain brown. I am anxious to trace the southern boundary of the region in which these animals make this change—become white. I should be grateful, therefore, if any naturalist, trapper, or other reader of this journal, who believes he lives near this sought-for southern boundary, would send me word upon a post-card, or by letter, whether the weasels in his locality turn completely white, or only partly so, or whether some turn and others do not; and also whether the change appears to him to depend upon the coming of snow—that is does its time vary with the comparative earliness or lateness of a season?

Ernest Ingersoll

364 West 121st Street,
New York City

SCIENTIFIC MEN AND PHONETIC SPELLING

To the Editor of Science: Professor J. C. Arthur, of Purdue University, says in Science for October 10, 1913, p. 513:

> He is a brave man who openly throws stones at another man's domicile, even if he justify the act as altruistic, knowing the proverbial danger incurred.

Professor Arthur thereupon bravely throws stones at Dr. Dabney, and now I wish to throw a few friendly stones at Professor Arthur, at Dr. Dabney and at most of the other eminent contributors to Science. True,

> It is not the proper plan
> For any scientific gent to whale his fellow man.

But throwing stones is not "whaling," and all scientific gents will agree that a mere philologist can not be himself a scientific gent according to the statute in that case made and provided.

Professor Arthur chides Dr. Dabney for using the phrase "fungus growth," though he would excuse the phrase if it were intended for "fungous growth," "with the *o* accidentally omitted." But suppose Dr. Dabney, like some other scientific men, for example Dr. Wilder, should spell the adjective *fungous* with the *o* intentionally omitted? Would that be a violation of "good English" or of "good grammar"? Many scientific men would say so. Other scientific men would not say so.

The point that I make is that many contributors to Science, in criticizing matters of language and grammar, ignore a much more important matter in the relation of science to language. Even the gentlemen who write long and interesting articles about nomenclature, and insist with vehemence on the retention of this or that name or spelling or misprint, because it happened so (surely a free and easy attitude in science), do not touch upon the vital point. Most of them, by their example, or by abstaining from utterance or action, are preventing the scientific discussion, and the scientific settlement, of important matters of language relating to science. That is, they will not consider or discuss, or help others to consider or discuss, in print, the scientific notation of the English language, or of other languages. By their conservatism, obscurantism, ignorance, indifference, apathy, hostility, fury, cynicism, geniality, orthodoxy, call it what you will (and it is some or all of these), they prevent the editors and readers of the journals of science from dealing with this important matter of science.

They may write to their journals about the pronunciation of this or that word, sometimes about the etymology of this or that word, but, usually what they write, or at least what is printed, is superficial, insufficient or inexact; in a word, unscientific.

The reason is, I suppose, that most of the orthodox men of science do not know anything, accurately, about the pronunciation of English words, or about the sounds of English, or about the sounds of any language. They do not know, and will not try to find out, what symbols they should or might use in order to indicate with accuracy the sounds they wish to indicate or to discuss. And even those who do know these things, and can use, with a pen, an adequate notation of sounds, can not present that notation in the pages of a scientific journal, unless by a special arrangement with a more or less reluctant editor or group of editors, or at an expense which the writer himself must meet. In short, the orthodox scientific men of the United States and of Great Britain are, in this

matter, either unscientific, or are prevented, by some of their orthodox leaders from being scientific, in what should be an elementary matter of science, namely the accurate ascertainment and the intelligible record of the sounds of the English language, and of the other languages used in science. They are thus hostile to the sciences of philology and phonetics; and some openly proclaim their hostility.

If any of your correspondents who may do me the honor to dissent from these views will attempt to state in SCIENCE (and I am sure that the editor would be willing to permit the experiment) the actual facts about the words which Professor Arthur mentioned, namely, *fungus, fungous,* and *fungoid* (or any other group of words offering like conditions); to state exactly, in print, the pronunciation which those words have or should have; to state exactly what is or what should be the plural of *fungus;* to state exactly the nature of the difference between *funguses* and *fungusses;* to state exactly the different pronunciations of *fungi;* to state also whether the word so spelled is Latin or English, and whether it is Latin or English in all its pronunciations, or in one—if any one will try to do this, and succeed in doing it without recourse to the abhorred science of philology, and the despised "fad" of phonetics, I should like to see the result.

Even in the much simpler matter of a modernized spelling of English, we find the scientific journals holding aloof from the scientific view, and clinging to an unscientific and medieval spelling, while, nevertheless, in their columns we find frequent jibes or jabs at other medieval superstitions, and at other popular errors.

Yet nearly one fourth of the men who are recorded in Dr. Cattell's biographic dictionary, "American Men of Science," in the first edition, signed a card agreeing to use some simplified spellings, and thereby gave the idea the value of their approval. No doubt they still cherish the same sentiments. In fact, some of them cherish these sentiments so fondly that they are wholly unwilling to part with them, or to share them with the public. So they wrap themselves in their intellectual integrity, put over that the cloak of scientific orthodoxy, and go about disguised as harmless men. And the directors of scientific societies and institutions sit and do likewise. Then they arise and print pretty things about science and progress.

And longer should I sing, but with a frown the editor, impatient, rises. Having thus laid myself open to a lapidation of my meter (which some scientific gents *will* spell "metre," or die in the attempt), not to say of my orthographic orthodoxy, I blush and drop my sling—before I smile a sickly smile and curl up on the floor.

CHARLES P. G. SCOTT

SCIENTIFIC BOOKS

Gas Analysis. By L. M. DENNIS, Professor of Inorganic Chemistry in Cornell University. New York, The Macmillan Co., 1913. Pp. 434. Price $2.10 net.

This book may perhaps be described as the American Hempel. It is based upon the translation of Hempel's last edition, but extensive additions have been made by the author. The reviewer has always considered the plan of publishing researches in a text-book open to question, even though this adds materially to the value of the book to the investigator. It would seem better to make them much more widely known by having the researches appear in a periodical.

It is fair to expect in a work of its size that it should be encyclopedic and that the latest work should be included. No mention however is made of Uehling's automatic apparatus for analyzing chimney gas; of the Sargent gas calorimeter; of Elliott's gas apparatus, which is probably the most widely used of any for illuminating gas; of Hinman-Jenkins's method for total sulphur; of Crafts's method for purifying mercury; of the excellent work of Burrell and others of the Bureau of Mines in analyzing mine gases; of the detection of carbonic oxide by birds and mice; of the absorption of hydrogen by palladium chloride; of the practical application of chimney-gas analysis and of the calculations involved.

It is difficult to see in a work devoted exclusively to gas analysis why nearly a chapter should have been given to the heating value of solid fuel; or why the practically obsolete Honigmann gas burette should be described; or why the method of Drehschmidt-Hempel for total sulphur—which is almost never used in this country—is included.

One can not help being struck by the way in which reference has been avoided to American apparatus, and to a lesser degree to American work in this field. For example, Fig. 26 is of a German wet gas meter with the information that it can be obtained from Elster of Berlin! This extreme conservatism or love for German apparatus leads the author still to use the form of sulphuric acid pipette (p. 247) which is slow and may give rise to inaccurate results; to employ the expensive and clumsy double absorption pipette (p. 57) which is difficult to fill and empty; to fasten the gas pipettes with plaster of Paris (p. 54) into their fixed iron supports, instead of using screw clamp holders or a wax that can be melted and a movable collar which allows pipettes of almost any dimensions to be employed; and finally to say (p. 85) that the rubber protecting bulbs for the Orsat pipettes are a "drawback" or "rapidly deteriorate"—which those of German make certainly do; had he used those of good American manufacture he would have had no trouble. It was shown years ago how all these difficulties could be avoided and experience with hundreds of students has confirmed the methods then recommended.

In spite of these defects the book has many excellent features. Chapter XI., on the calculations involved in the combustion of gases, is especially good, as is also the treatment of ozone and carbonic oxide. The chapter on acetylene is very complete. Among new apparatus is mentioned the gas refractometer and rotameter, and also some gas absorption bottles; among new methods may be noticed the determination of hydrogen by colloidal palladium and of oxygen by sodium hyposulphite. The book is particularly valuable in research or to the experienced man.

A. H. GILL

Mechanism. By ROBERT MCARDLE KEOWN, B.S., Assistant Professor of Machine Design, University of Wisconsin.

Professor Keown has attempted in this book to give a brief treatment of the subject of mechanism in such a way as to furnish material for half a school year's work of six hours per week partly in the class room and partly in the drafting room. The book contains little that is new in the way of subject matter covered and there is much similarity to other and older text-books in the general method of handling certain parts of the subject. The order in which the various mechanisms are considered is radically different from that usually followed and impresses one at first as being rather questionable, although the author seems to have found it satisfactory in his own teaching.

Chapter I. gives the usual discussions and descriptions of motion, velocity, etc., most of which are well stated. The student is then plunged at once, in Chapters II. to V., into the consideration of link work with all its intricacies, so puzzling to the student whose imagination has not yet been trained sufficiently to enable him to readily grasp this rather difficult part of the work.

Chapter VI. presents a fairly thorough and clear treatment of the subject of cams and is particularly well illustrated with a large number of diagrams and pictorial drawings.

Chapters VII. and VIII. treat the subject of gearing both for parallel and non-parallel shafts. The treatment is clear, with considerable practical information and a number of good illustrations.

Very little attention is given to the important matter of trains of gears. A short chapter is devoted to connection by means of belts, chains, and ropes, and another short chapter to various mechanisms for giving intermittent motion. The book contains a large number of illustrations, many of which are exceptionally good. A number of problems are given at the end of each chapter, adapted both for class room work and for solution on the drawing board. These form a valuable part of the book.

W. H. JAMES

Elementary Machine Design. By William C. Marshall, Assistant Professor of Machine Design in Sheffield Scientific School of Yale University.

This book is prepared for the use of students who have not studied mechanics or mechanism. It is in reality a book of information and instructions for a course in drawing various machine details. The course as outlined would give a student familarity with many of the details of machine construction and considerable practise in drawing them. No attempt is made, however, to give training which would enable the student to look at a problem in machine design in a broad way and to attack it understandingly. It seems fair then to call it a book of information rather than a text-book either of machine design or machine drawing. It would be a valuable handbook for a draftsman who is already familiar with the principles and methods of machine design.

The first chapter consists of a discussion of machine drawing, general in some respects and minute in others. The other chapters treat of rivets and riveted joints, piping, screws and bolts, shafting and shaft couplings, stuffing boxes, bearings, journals, hangers, pistons and piston rods, connecting rods, pulleys, belting, gearing, valves. Under the head of "Useful Information" are a number of convenient tables, and similar tables are scattered through the book.

W. H. James

Grundriss der Kristallographie. By Dr. Gottlob Linck. Third Revised Edition. Jena, Verlag von Gustav Fischer. Pp. viii + 272. Figs. 631. Colored Plates, 3. Price 11.50 Marks.

The appearance of a third edition of this excellent text-book of crystallography only five years after the publication of the second edition is an indication that its author has succeeded in treating what is usually regarded as a dry subject in a way that has attracted many readers. A part of the popularity of the volume is due no doubt to the fact that crystallography is being studied abroad more and more thoroughly by chemists and physicists since the spread of interest in physical chemistry. Unfortunately, in America the science has few followers, but in Germany and England it appears to be enjoying a renaissance. Crystallography no longer deals merely with the description of crystal forms and the calculation of crystal constants. In its modern phase it is more directly concerned with the relations that exist between the forms and properties of substances and the proper explanation of these relations. Crystallography is rapidly becoming a branch of physical chemistry. It is because the author has realized this tendency in the science and has given us a book that deals so fully with the fundamental conceptions of physical and chemical crystallography that his volume has been received with such universal favor.

Of the new edition, 96 pages are devoted to the discussion of crystal forms and the balance to the discussion of the physical and chemical properties of crystals. There is no difference in method of treatment in the second and third editions. There are 27 more figures and 18 more pages in the new edition, but these additions are simply expansions of a few of the topics treated in the earlier edition. The additional figures were introduced mainly to emphasize some of the statements concerning the mechanical and optical properties of crystals, and the additional pages are the result of a little more detailed discussion of their optical properties. Throughout the book, where necessary, the text has been changed to bring it up to date and a few paragraphs have been introduced to call attention to some of the recent new work on crystals. The new figures are all of the same high grade of excellency as those characterizing the second edition.

The new edition is unquestionably the handsomest, best proportioned, most concise and at the same time most comprehensive elementary text-book on crystallography in any language. It is readable because logical, and it is modern. Moreover, it is not burdened by the involved sentences and the otherwise atrocious style that characterize so many German science text-books.

W. S. Bayley

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 15 of the *Transactions of the American Mathematical Society* contains the following papers:

T. H. Gronwall: "On the degree of convergence of Laplace's series."

L. E. Dickson: "Linear associative algebras and abelian equations."

W. B. Fite: "Some theorems concerning groups whose orders are powers of a prime."

R. E. Root: "Limits in terms of order, with examples of limiting element not approachable by a sequence."

O. E. Glenn: "The symbolical theory of finite expansions."

B. H. Camp: "Lebesgue integrals containing a parameter, with applications."

J. L. Coolidge: "Congruences and complexes of circles."

The Decmber number of the *Bulletin of the American Mathematical Society* contains: Report of the Madison Colloquium, by Arnold Dresden; Report of the Vienna meeting of the Deutsche Mathematiker-Vereinigung, by Virgil Snyder; "On binary modular groups and their invariants," by L. E. Dickson; "On some systems of collineation groups," by H. H. Mitchell; "On the sumability of Fourier's series," by T. H. Gronwall; "Note on Pierpont's Theory of Functions," by G. A. Bliss; Review of Reid's Theory of Algebraic Numbers, by E. B. Skinner; Review of the Festschrift Heinrich Martin Weber zu seinem siebzigsten Geburtstag, by R. C. Archibald; "Shorter Notices": Murray's Plane Trigonometry and Tanner and Allen's Analytic Geometry, by C. B. Hennel; Müller's Gedenktagebuch für Mathematiker and Ebner's Technische Infinitesimalrechnung, by E. W. Ponzer; Webster's Dynamics of Particles and of Rigid, Elastic and Fluid Bodies, by W. R. Longley; "Notes"; and "New Publications."

THE January number of the *Bulletin* contains: Report of the October meeting of the society, by F. N. Cole; Report of the twenty-fourth regular meeting of the San Francisco Section, by Thomas Buck; Report of the seventh regular meeting of the Southwestern Section, by O. D. Kellogg; "The infinite regions of various geometries," by Maxime Bôcher; "Shorter Notices"; Auerbach and Rothe's Taschenbuch für Mathematiker und Physiker, by G. A. Miller; Sommer-Levy's Théorie des Nombres algébriques, by E. B. Skinner; Carslaw's Infinitesimal Calculus, by A. M. Kenyon; Young's Monographs of Modern Mathematics, by R. D. Carmichael; Hawkes's Higher Algebra, by J. E. Rowe; Evans's Teaching of High School Mathematics, by E. R. Lytle; Fischer's Koordinatensysteme, by E. J. Wilczynski; "Notes"; and "New Publications."

THE February number of the *Bulletin* contains: "Some theorems on the convergence of series," by R. D. Carmichael; "A translation principle connecting the invariant theory of line congruences with that of plane *n*-lines," by O. E. Glenn; "Some mathematical booklet series," by R. C. Archibald; "Mathematical models," by R. C. Archibald; Review of Darboux's Systèmes orthogonaux et Coordonnées curvilignes, by E. J. Wilczynski; Review of Church and Bartlett's Descriptive Geometry, Low's Practical Geometry and Graphics, Hauck's Darstellende Geometrie, and Müller's Darstellende Geometrie für technische Hochschulen, by Virgil Snyder; "Shorter Notices"; Hensel's Zahlentheorie, by L. E. Dickson; Volterra's Equations intégrales et Equations intégro-différentielles, by Jacob Westlund; Kowalewski's Komplexe Veränderlichen und ihre Funktionen, by Arnold Dresden; Bachelier's Calcul des Probabilités, by H. L. Rietz; Einstein and Grossmann's Verallgemeinerte Relativitätstheorie, by E. B. Wilson; "Notes"; and "New Publications."

THE BOTANICAL SOCIETY OF AMERICA

II

The Anatomy of the Node as an Aid in the Classification of the Angiosperms: E. W. SINNOTT.

The node of vascular Cryptogams and Gymnosperms is recognized as a conservative region. Investigation shows that the nodal structure of Angiosperms, as well, is slow to change and is

therefore of value in classification. In the Conifers the foliar supply leaves only a single gap in the cylinder, but in the lower Angiosperms the several traces which supply every leaf come off from the stele some distance apart and each causes a gap of its own. The primitive number of foliar traces and corresponding gaps among Angiosperms seems to have been three. This is characteristic of the Amentiferæ, the simpler Ranales, the Urticales and the Rosales. It also persists in some of the higher orders, such as the Caprifoliaceæ and Compositæ. In other groups, this condition has been amplified into one with a large number of strands and gaps, as in the Magnoliaceæ, the Polygonales, the Araliales and the Monocotyledons. In still others the three gaps have become approximated and merged into one, as in the Centrospermæ, Myrtales, Ericales, Ebenales and Tubifloræ. The great simplicity of these nodal characters and their uniformity throughout such large groups of plants make them of much value in determining broad lines of relationship.

Primitive Characters Recalled by the Chestnut-bark Disease and Other Stimuli: I. W. Bailey and J. S. Ames.

Dicotyledonous leaves with entire margins predominate in tropical regions, but are comparatively infrequent in boreal and mountainous regions. Subtropical and tropical representatives of boreal families have commonly entire leaves. Deeply lobed, dentate or serrate leaves are characteristic of Fagales endemic in northern latitudes. Toward the tropics the margins of the leaves become progressively entire. It seems probable that all living representatives, at least, of the Fagales, are descendants of boreal or mountainous forms, since vestiges of lobes, dentations and serrations persist upon young vigorous plants of subtropical species. Furthermore, the boreal type of foliage is recalled in mature parts of these plants by the stimulating effects of very rapid vigorous growth and the irritating effects produced by the attacks of insects and fungi. A striking illustration of these phenomena is afforded by the common American chestnut, *Castanea dentata* Borkh. Foliage formed subsequent to severe infections of the chestnut-bark disease (*Endothia parasitica* Murrill) is typically oak-like, frequently resembling closely *Quercus rubra* L. The reversion is not confined, however, to external characters. For the wood formed by the diseased cambium possesses anatomical structures which are a characteristic feature of the genus *Quercus*.

The Archegonium of Sphagnum subsecundum: George S. Bryan.

Sphagnum subsecundum, where studied in the region near Chicago for the past two autumns, has been found to bear enormous numbers of sex organs. The archegonial and antheridial heads are not difficult to recognize, and may be easily distinguished from each other.

A careful study brings out the following facts, as a general statement, in regard to the development of the archegonium. Archegonia are fonnd to occur terminally on short side branches which rise near the apex of the main stem. The apical cell of one of these branches becomes an archegonial primordium in which oblique walls appear. The cell above these walls produces the primary archegonium; while each lateral segment cut off by them forms a secondary archegonium. In the archegonium initial the first wall is transverse, and usually subsequent transverse apical divisions give rise to a filament of cells varying in number from four to six. In each cell of the filament secondary divisions occur. Finally the apical cell of the filament enlarges and oblique walls, followed by a transverse wall, cut out a cover cell and a central cell. The cover cell forms chiefly the cap of the archegonium, while the central cell on division produces a primary canal cell and a ventral cell. The primary neck canal cell gives rise to a veritable number of neck canal cells, frequently from six to eight. The ventral cell divides very late, forming the ventral canal cell and the egg. Usually just after this latter division the neck canal cells break down, but the ventral canal cell is persistent, rounding off and coming to lie in the venter near the egg, from which it may be distinguished by its slightly smaller size. Shortly before fertilization the ventral canal cell goes to pieces.

So-called abnormalities occur. Two eggs and two ventral canal cells occur occasionally, while in one case a large venter was found in which were ten such cells.

On the Structure and Relationships of Macroglossum: D. H. Campbell.

Macroglossum Copeland is a genus of Marattiaceæ, founded upon a species, *M. Alidæ*, sent from Sarawak in Borneo. The writer collected it at two stations in February, 1913, and secured material of both sporophyte and gametophyte. Another species was found growing in the botanical gardens of Buitenzorg, under the name *Angiopteris Smithii* Raciborski. The origin of this lat-

ter plant is unknown, but it was probably brought from Borneo.

Macroglossum differs from *Angiopteris* in several important respects. It has simply pinnate leaves, much more like *Danæa* than *Angiopteris*. The sporangia, while distinct, are quite different from those of *Angiopteris*, and closely resemble those of *Archangiopteris* The number of sporangia in the sorus is much greater than in *Angiopteris*, sometimes exceeding 60. The indusium is also much better developed than in *Angiopteris*. There are also some important anatomical differences in the leaf structure.

Macroglossum is a large fern, the leaves being about four metere in length. In habit it resembles a gigantic *Danæa*—and also suggests strongly some of the larger species of *Zamia*. The leaflets reach a length of over 50 centimeters.

The prothallia are very large, sometimes nearly three centimeters in length by two in breadth. They are monœcious. The antheridia are very large, but otherwise much resemble those of *Angiopteris*, as do the archegonia. The embryo has a conspicuous suspensor.

Macroglossum undoubtedly belongs to the Angiopterideæ, but its affinities are rather with *Archangiopteris* than with *Angiopteris*. Like *Archangiopteris* it suggests a distant relationship to *Danæa*.

Morphology of Thismia (Bagnisia) americana n. sp.: NORMA E. PFEIFFER.

Among the Burmanniaceæ the forms closely related to *Thismia americana* have been found up to date only in the southern hemisphere, mostly in the Malay Archipelago. The particular subdivision to which this *Thismia* shows affinities has been for the most part discovered in recent years. The finding of one in a region so remote from the home of its relatives as Chicago, augurs well for the possibility of other undiscovered forms. The reduced size and anatomy of this saprophytic form are noteworthy. The floral axis arises simultaneously with a secondary root from the main root. The structure of the flower is similar to that of other *Thismias* of the *Bagnisia* section. Floral development is somewhat similar to that in the Orchidaceæ, to which resemblance in other features is evident. The characters are deemed sufficiently distinctive to warrant the establishment of a new species.

Some Observations on the Anatomy and Other Features of the Black Knot: ALBAN STEWART.

Enlargements, popularly known as "black knots," are formed on the branches of *Prunus virginiana* L. and other species of cherries, by the attack of the fungus *Plowrightia morbosa* (Schw.) Sacc. These knots may arise primarily through the infection of the branch by means of spores, or, secondarily, by the spreading of the fungus through the tissues from a knot already formed.

Normal wood of *P. virginiana* usually contains rays from one to four cells wide in cross section. As a result of the stimulating action of the fungus these rays may become much broader in infected tissue, simulating the structure of compound rays. The production of the usual elements of the xylem is greatly inhibited during the first season's growth of the knot, but there is a correspondingly great production of xylem parenchyma, which is almost absent from normal wood. By further increase in size of parenchyma cells the knot is greatly enlarged during the second season of its development. The cambium is pushed outward by this means, and with it are isolated groups of fibers and other xylem cells. There is also an abnormal growth of the ray tissue at about this time, which ruptures the cambium, opposite the raye, and pushes segments of it outward into the bark. By further division of these misplaced cambium cells, various xylem elements are produced in the bark very much out of their normal position. The segments of the cambium, which remain between the rays, retain their relative position throughout the subsequent development of the knot, and give rise to wedges of xylem each of which is subtended by a mass of phloem on the outside.

There is apparently no abnormal growth in the outer portion of the bark. It is sloughed off just before the conidia are produced.

Homologies of the Frond in Lemna: FREDERICK H. BLODGETT.

The plant body in *Lemna* has been considered by various authors as a leaf, a stem or a combination of these, but in most cases little morphological evidence is advanced for one or the other idea. The structure of the frond, especially during its early stages, is used as the basis of a discussion of the parts present. It is concluded that the frond represents a single leaf at the tip of a stem of one internode, at the tip of which a dichasial stem apex is located, and ventrally an adventitious root developed. The dichasial buds are protected by the sheath or pouch of the frond, which develops simultaneously with the buds, from the tissue immediately about the insertion of the buds upon the apical tissues, becoming congenitally

fused with the basal margin of the leaf and the lateral margin of the stem (stipe) just where this unites with the leaf.

The vertical restriction upon axial growth is found to limit the development of new parts to the horizontal plane, and successive outgrowths are produced as lateral developments rather than in a vertical succession as in normal erect stems. No new parts are found, but those present have undergone reduction as a result of adaptation to the floating habit.

Development of the Embryo and the Germination in Lemna perpusilla: Frederick H. Blodgett.

The embryo of *Lemna* develops directly from the egg cell, all of which is involved in the formation of the embryonic tissues, a true suspensor not being differentiated. The plumule becomes folded against the hypocotyl so that its tip is just under the micropyle. In this position it is enclosed by the overgrowth from the base of the cotyledon, forming a sheath or pouch. At the base of the plumule a bud is developed, which is the first true frond, and this bears the first pair of buds characteristic of the dichasial branching of the plant. The anterior half of the embryo is the cotyledon, and acts as an haustorial organ during germination, and does not function otherwise. The plumule emerges from the sheath from a horizontal slit, thus lying from the first in the plane of the water surface. The germination of the seed is in general of the type of *Pistia*, differences being due to the greater degree of reduction in the case of *Lemna*, rather than inherent variations in method.

The Chemical Dynamics of Living Protoplasm: W. J. V. Osterhout.

Van't Hoff's formulation of the laws of chemical dynamics has proved so stimulating to various fields of chemistry that it may be expected to be similarly useful if it can be applied to the activities of living protoplasm. The writer finds that by measuring the electrical resistance of living tissues it is possible to follow the progress of reactions in protoplasm in the same way that van't Hoff followed the progress of reactions *in vitro*. It therefore becomes possible to apply van't Hoff's methods and formulæ directly to protoplasm in its living and active condition. The following example will suffice to show how this may be accomplished.

The electrical resistance of living tissue of *Laminaria* was measured by a method which has been previously described. The tissue had in sea-water a resistance of 980 ohms. On being placed in NaCl .52M (which had the same conductivity as sea-water) the resistance fell after 10 minutes to 865 ohms and after 20 minutes to 745 ohms: it continued to fall rapidly and finally became stationary at 320 ohms. This represents the death-point. The total change produced by the NaCl was $930 - 320 = 660$ ohms. In order to find out whether this change had been produced in such a way as to correspond to a known type of chemical reaction the amount of change was measured at brief intervals.

According to van't Hoff we can determine from such measurements whether one, two or more substances are taking part in the reaction. If only one substance takes part (or if two substances take part but only one of them changes its concentration noticeably) the reaction is said to be of the first order (monomolecular) and it proceeds according to tho formula

$$k = \frac{1}{t} \log. \frac{a}{a - x},$$

in which t is the time which has elapsed between the beginning of the reaction and the taking of the measurement, x is the loss in resistance at the time t, a is the total amount of change in resistance when the reaction is completed and k is a constant (called the velocity constant) which indicates the speed of the reaction. If the reaction is of the first order (monomolecular) k should come out constant provided the temperature be kept constant during the reaction.

In this case a, which represents the total amount of change, is $980 - 320 = 660$ ohms, while x represents the loss of resistance after 10, 20, 30 minutes, etc. The calculations show that k is nearly constant: the variations are no greater than are commonly found in measuring chemical reactions in the test-tube.

Since the effect of NaCl is within wide limits completely reversible, without production of injury, *the conception of chemical dynamics here developed applies not only to reactions which produce death, but also to reactions which involve no injury* and which form a normal part of the activity of the cell. This conclusion is fully confirmed by experiments with a variety of other substances.

A Contribution to the Theory of Antagonism: W. J. V. Osterhout.

By means of electrical measurements of living tissues it is possible to predict which salts will antagonize each other when allowed to act upon these tissues.

Differential Permeability: W. J. V. OSTERHOUT.

Various kinds of surfaces in the cell, such as the outer "plasma membrane," the vacuole-wall, the nuclear wall, the surface of the chromatophore and the cell wall can be proved to differ greatly in their behavior with respect to permeability.

The term differential permeability may be suggested as an appropriate designation of these phenomena.

The Effect of Antagonistic or Balanced Solutions Containing Sodium Chloride together with One of the Chlorides of Calcium, Magnesium, Potassium, Strontium, Ammonium or Copper, upon the Growth of Corn Plants Rooted in an Artificial Soil: JOSEPH S. CALDWELL.

The primary purpose of the work was to determine in how far the use of a solid medium having known physical properties may modify the antagonistic relationships borne by sodium to each of the other ions named.

For each of the six pairs of salts, cultures were grown in finely divided quartz to which the salt mixtures were added, the optimum water content for the quartz being maintained constantly throughout the experiment. For each pair of salts, ten to twenty different concentrations were used, the lowest of such concentration as to totally inhibit development, the last so dilute as to be entirely without effect upon the plants. For each of these concentrations, a series of cultures consisting of twelve to sixteen mixtures of the two salts in proportions ranging from 60:1 to 1:60 was made, with check cultures in each of the pure salts. The complete series for any pair of salts, therefore, shows for each salt the range of inhibitory, toxic and stimulatory effects, for comparison with the effects of isosmotic mixtures in varying proportions with the opposing salt. In all cases, results are measured by comparison of the dry weights of roots and tops, taken separately, for cultures allowed to grow under controlled conditions for 30 days.

Antagonism between sodium and strontium manifests itself at all molecular ratios between Sr 1: Na 10 and Sr 1: Na 20, and in all concentrations between those just permitting measurable development and those too dilute to have discoverable effect, but manifests itself only through its effect upon root development.

The effect of additions of calcium to sodium is merely to decrease the characteristic physiological and morphological effects of sodium in a degree directly proportional to the amount added, but in no case can these characteristic effects be made entirely to disappear. The effect of calcium is a dilution effect and not an antagonistic one.

In mixtures of copper and sodium, sodium serves merely to dilute the copper salt, decreasing the toxic or the stimulatory effect in direct proportion to the amount added, but in no case annulling the effects of the copper ion.

Additions of magnesium to sodium in any proportions or at any concentration is without effect upon the development of aerial parts. In highly toxic concentrations, mixtures in the ratio of Mg 2: Na 1 give somewhat better development of roots, while in all stimulatory concentrations the ratio 1:1 gives greatest dry weight for roots. Mixtures of sodium and potassium inhibit development of both roots and tops, in all inhibitory or toxic concentrations, to a markedly greater extent than do isosmotic solutions of the pure salts. In stimulatory concentrations, the pure salts permit greater and more normal development than do mixtures. Sodium in any proportion, even in concentrations at which it is markedly stimulatory, decreases the stimulatory effect of potassium.

For mixtures of sodium with ammonium, highly toxic concentrations permit slightly greater development when the two ions are present in the ratio 1:1. For all stimulatory concentrations, the stimulatory effect is decreased in mixtures, growth becoming better as the ratio of one ion to the other increases from 3:1 to 60:1.

Metabolic Changes in Potato Tubers During Sprouting: CHAS. O. APPLEMAN.

The following metabolic changes occurred during the early stages of sprouting: (1) Under constant storage temperature the starch was depleted, while the reducing sugars showed a slight increase. The above carbohydrate changes were more rapid in the stem end. (2) Both diastase and invertase activity of the glycerine extract quickly doubled; the increase was greater in both cases in the extract from the stem half. (3) Catalase showed a marked increase which was slightly greater in the juice from the seed end where it was more active before sprouting. (4) The nitrogen of monamino-acids and their amide derivatives increased, while the nitrogen of diamino-acids and other organic bases and the water-insoluble protein nitrogen decreased. The abundant water-soluble protein nitrogen in the tubers showed a very slight increase. (5) Organic extractive and lipoid phosphorus increase at the expense of protein and inorganic phosphorus.

The increase in lipoid phosphorus began earlier in the seed end and increased more rapidly in this end. The decrease in the inorganic phosphorus at the same stage of sprouting occurred in the seed end only. It is interesting to note that in many cases the metabolic activity was greater in the stem half, although the sprouts were all borne on the seed end.

Biochemical Study of After-ripening in the Potato Tuber: Chas. O. Appleman.

Under normal conditions potato tubers will not sprout for several weeks after harvest. During this rest period certain changes occur in the chemical or physical situation of the buds or their immediate environment, which are essential to the release of the growth processes. These changes will be spoken of as after-ripening, using the term in its broadest sense.

The tubers used in this investigation produce sprouts much earlier from the buds on the seed end. The tubers were therefore cut in half and the analyses made separately on the seed and stem halves with the view to better detect the chemical changes characteristic of after-ripening.

The carbohydrate transformations during the rest period are dependent entirely upon changing temperature. Active diastase is present at all stages of the rest period and shows no increase during natural after-ripening. Protein, lipoid, organic extractive and inorganic phosphorus, calculated to per cent. of total phosphorus, each remain constant up to the time of sprouting. After-ripening does not involve proteolysis or other changes in the various nitrogen combinations.

Metabolic changes involving the above substances and some others studied, begin rather suddenly and are concurrent with sprouting. They are, therefore, not primary processes of after-ripening.

The Physiology of the Rest Period in Potato Tubers: Chas. O. Appleman.

The rest period of the potato tuber is not firmly fixed and hereditary, as it can be entirely eliminated by means which will effect a proper adjustment between the bud tissue and external agents.

The Nutritive Value of Glycocoll to Plants from Peat Soils: A. Dachnowski and R. Gormley.

In this preliminary statement data are submitted which were obtained from experiments in the laboratory with a variety of wheat and with several bog plants, among them *Oxycoccus, Scheuchzeria* and *Juncus*. Aside from the nutritive inequalities of amino compounds, the attempt is made to determine the limiting concentrations of organic and inorganic acids and how far fungal micorrhiza are of importance in any special absorptive powers of plants.

Twining of Plants as Related to Withdrawal of Light: F. C. Newcombe.

Various plants when deprived of light lose, in the course of a few days, their power of circumnutation, and pursue a straight course, either orthotropic or plagiotropic. This loss of circumnutation is not a starvation phenomenon, but is due to a change in geotropic sensitiveness. When the plant is restored to the light, it regains, after several days, its twining ability.

Influence of Light on Infection of Certain Hosts by Powdery Mildews: George M. Reed.

An attempt has been made to study the influence of various factors as water supply, temperature, mineral starvation, light, etc., upon infection of hosts by powdery mildews. The results here reported relate to the influence of light.

Seedlings of barley and wheat have been grown in the dark until the first leaf was about 2 to 3 centimeters long. The plants were then inoculated with the mildew from their respective hosts. Some of the plants inoculated were kept continuously in the dark; others were removed at once and placed in the light; at intervals of 24 hours other inoculated plants were taken from the dark and placed in the light. The general results were that no infection occurred if the plants were kept in the dark after inoculation. Upon their removal to the light, infection occurred in proportion to the degree to which the etiolated leaves turned green. In general the period of incubation was retarded proportionally to the time the plants were kept in the dark.

Another series of experiments was carried out, first growing the plants in the light and then, after inoculation, placing them in the dark, some immediately, others at intervals of 24 hours. In the case of the plants placed at once in the dark no infection occurred. Those, however, that were kept in the light for one or two days became infected. The period of the incubation of the fungus, however, was materially retarded. In general the effect of the absence of the light upon the mildew is considered to be an indirect one and has to do with the primary effect upon the development of chlorophyll in the host cell. The infection fails to occur in those cells which have not developed the chlorophyll. The mildew then is a strict parasite attacking cells which are not capable of carrying on their normal functions.

These results are quite different from those obtained by inoculating etiolated plants with saprophytic fungi. Under such conditions, in some cases at least, saprophytic fungi are able to develop on the living tissues.

Resistance of Certain Fern Prothallia to Extreme Desiccation: D. M. MOTTIER.

The prothallia of *Camptosorus rhizophyllus* and of other forms found on dry hillsides and on limestone cliffs have been subjected to conditions approximating prolonged drought in the natural environment and to conditions of extreme desiccation in the laboratory. The part the prothallia play in the ecological adaptation of these ferns is shown by their survival of the most extreme laboratory conditions and by their subsequent production of sporophytes. For example, prothallia of *Camptosorus* survive exposure to glycerine-dried air for a period of six weeks, and those of other genera even a more extended desiccation under similar and different conditions. A continuation of work published in the November number of the *Bull. Torr. Bot. Club.*

The Pyrenoid of Anthoceros: F. McALLISTER.

All of the cells of the gametophyte of *Anthoceros lævis* contain a single large chloroplast, each of which has near its center a pyrenoid. The pyrenoid is not a homogeneous, kernel-like structure, as is the case in the algæ, but is a multiple structure made up of a dense group of from 25 to 300 disc- or spindle-shaped bodies. These bodies are protein according to the standard microchemical tests. During photosynthesis the outer bodies are transformed directly into rudimentary starch grains while new bodies seem to be formed in the interior of the mass by fission. The rudimentary starch grains increase in size as they are pushed toward the periphery of the chloroplast by younger starch grains.

In the embryonic tissue of the sporophyte the pyrenoid can not be identified, but as these cells are pushed upward scattered bodies seem to eggregate in the center of the chloroplast to form it. When fully formed it differs in no way from the pyrenoid of the gametophyte. In the sporogenous layer, however, no pyrenoids are visible and the abundant starch grains of the spore mother-cells and the spores seem to be formed much the same as in other Bryophytes.

Physical Factors in the Cleavage of Cœnocytes: R. A. HARPER.

In the Myxomycete *Didymium* we have the spores formed by progressive cleavage essentially as in *Fuligo* and the sporanges of the Mucorineæ. The presence of a capillitium of radial fibers, however, apparently makes possible the manifestation of certain factors in the process of division which are not so easily recognizable in other cases. The first visible step in cleavage seems to consist in the extrusion of water from the protoplasm. This water collects to form from one to several vacuole-like bubbles on the capillitial threads. Further contraction and extrusion of water goes on till each capillitial thread comes to be enclosed by a watery sheath. Progressive cleavage by furrows now sets in from the surface of the spore sack and from the surface of these water sheaths around the capillitial threads. Ultimately we have uninucleate spores. The whole process seems to involve active extrusion of water, and if we conceive that the chemical constitution of the nuclei is such as to favor the retention of moisture in the cytoplasm immediately adjacent to them we should have a condition which would tend toward the orientation of the cleavage furrows in such a position as to lead ultimately to the production of uninucleated spore masses.

The Harmful Action of Distilled Water: R. H. TRUE.

It appears probable that the problem of injury by distilled water is not a simple one capable in all cases of a like explanation. In some cases, distilled water obtained from apparatus having copper surfaces exposed to contact with the water undoubtedly derives certain toxic properties from minute traces of copper. In other cases, doubtless, it is possible for other harmful impurities to find their way into the product, but after the action of all the impurities has been accounted for there still remains a residuum of harmful action due to no known type of impurity. This mode of harmful action seems to be most marked in water which shows the highest resistance to the passage of the electric current.

Samples of distilled water which show the highest resistance are in general more harmful to lupine roots than waters containing a large quantity of electrolytes. These same samples of water withdraw electrolytes from the tissues of the roots when they remain in the water. This leaching of electrolytes is shown to be the probable mechanism by means of which purer samples of distilled water exert their harmful action on the roots. This action has a physical osmotic component, but for the roots of *Lupinus albus*, this osmotic factor seems to be decidedly secondary

in importance, the primary cause of injury being the extraction of electrolytes and perhaps of other substances as well. This extraction by distilled water is regarded as but a special case of the general type of injury wrought on cells by unbalanced solutions whereby certain necessary constituents, undoubtedly in part inorganic, are dissociated from their proper attachments in the complicated chemical and physical mechanism of the living cell. The distilled water seems to withdraw material required for the maintenance of the efficient action of the protoplasmic limiting membranes, with the result that the permeability of the cells is increased, and a further dissociation of electrolytes from their points of combination in the proteids, and other chemical structures of the cell, ensues. These dissociated electrolytes escape from the cell and increase the conductivity of the distilled water. When a trace of calcium ions is present in the distilled water, this dissociating power of the distilled water over the proteids and other chemical mechanisms of the cells is largely developed, and the chemical integrity of the cells is protected in some way not known.

This report is preliminary in its nature and is to be followed at a future date by a further contribution reporting the results of work now under way.

Distilled Water in the Laboratory: R. H. TRUE.

With the discovery made by Nägeli and Loew that copper distilling apparatus may yield water containing traces of copper sufficient to render the water harmful for plant cultures, the use of glass distilling apparatus became general, and carefully distilled water obtained from glass came to receive the general confidence of biologists. While in the majority of cases this confidence is well placed, errors in the interpretation of results are likely to follow a failure to recognize and allow for certain chemical and physiological characteristics of so-called pure water. Aside from the difficulty of obtaining pure water, this substance having been prepared in a pure state but a few times and then by chemists and physicists, there is the further difficulty of maintaining it in a pure state, since it readily becomes charged with gaseous products of the air, and when exposed to the air of the laboratory is especially likely to assume harmful properties for plant cultures—a danger which may be minimized through taking precaution to exclude these impurities from contact with the water. Another source of almost unavoidable contamination is seen in the solubility of the usual glass containers, which, unless specially prepared for the purpose, give up to the water sufficient solids to steadily increase the electrical conductivity.

Since a minimum of impurities will be found even in the purest water obtainable for practical experimental purposes, the action of the dilute solution which goes under the name of distilled water comes up for consideration. It has been shown that "distilled water" is injurious to the roots of certain plants, and that this action is paralleled by, and probably due, in great measure, to, the leaching of constituents necessary to the maintenance of life activities.

When check cultures grown in distilled water are used as a standard of comparison and regarded as normal, great danger of serious error in interpreting the results of biological experiments arises, since the behavior of check cultures in distilled water can not safely be regarded as an expression of normal activity.

It appears that plant physiologists need in their work a normal physiological solution, this normal solution to be such a medium as will cause the least possible disturbance to the usual activities of the plant. While the difficulties introduced by the use of a normal physiological solution are many, and will necessitate great care not only in meeting different requirements of various types of plants, but also with respect to the purity of chemicals used, the insolubility of glassware, the quality of distilled water employed, etc., there seems to be little doubt that such physiologically approximate mixtures are likely to give results much more closely approaching physiological soundness than is possible with the use of distilled water.

GEORGE T. MOORE
Secretary

JOINT ANNUAL MEETING OF AMERICAN ANTHROPOLOGICAL ASSOCIATION AND AMERICAN FOLK-LORE SOCIETY

THE annual meeting of the American Anthropological Association was held in West Assembly Hall, American Museum of Natural History, New York City, December 29–31, 1913, in affiliation with the American Folk-Lore Society. The joint program was unusually long and more cosmopolitan than at any previous meeting, and the sessions were well attended. The thanks of the members of both societies are due to the American Museum

of Natural History for the ample and attractive facilities provided; to the Explorers' Club for the welcome extended to members of the Council, and to Mr. George G. Heye and Professor Saville for a private view of the Heye Museum.

At the Cleveland meeting the secretary was instructed to prepare a list of names of persons eminent in anthropology to be submitted with the view of election to honorary membership at the New York meeting of the association. Pursuant to his instructions the secretary submitted a list which was referred to a committee named by President Dixon: Boas (chairman), Hrdlička, Peabody and the secretary, with instructions to recommend five names. The report of this committee was approved and the following honorary members were elected by the council: Professor Léonce Manouvrier, Paris, France; Professor Karl von den Steinen, Berlin, Germany; Dr. Alfred P. Maudstay, London, England; His Excellency W. Radloff, Saint Petersburg, Russia; Professor Emile Cartailhac, Toulouse, France.

Dr. Goldenweiser reported for the committee appointed to consider the advisability of devoting one number of the journals (*American Anthropologist* and *Journal of American Folk-Lore*) to recent progress in the field of American anthropology in connection with the International Congress of Americanists to be held in Washington, D. C., October 5–10, 1914. The report was accepted and Dr. Goldenweiser was instructed to complete his correspondence with contributors and to send the contributions to the editors for publication. The editor of the *Anthropologist* was instructed to have extra copies of the number in question printed for free distribution among foreign members of the International Congress of Americanists. The contributions already promised are: "Archeology," W. H. Holmes; "Physical Anthropology," A. Hrdlička; "Material Culture," Clark Wissler; "Mythology," Franz Boas; "Linguistics," P. E. Goddard; "Ceremonial Organization," R. H. Lowie; "Religion," Paul Radin; "Social and Political Organizations," A. A. Goldenweiser; "Historical Relations," J. R. Swanton and R. B. Dixon.

Dr. Hrdlička gave a detailed report of the progress made by the local committee in preparation for the forthcoming International Congress of Americanists to be held in Washington, D. C. The American Anthropological Association accepted an invitation to become a member of the congress, to which President Dixon named Franz Boas, of Columbia University, and George Grant MacCurdy, of Yale University, as delegates from the association.

A letter was read from Professor A. L. Kroeber, who expressed the hope that the association would accept the invitation of Mr. James A. Barr, manager of the Bureau of Conventions and Societies of the Panama-Pacific International Exposition, to hold a special session in San Francisco during the exposition. Professor Kroeber announced his readiness to do everything in his power to help make such a meeting a success. The invitation was referred to the executive committee with power to act.

The selection of a place for the next annual meeting of the association was likewise left to the executive committee, which has decided that the meeting shall be held in Philadelphia during the Christmas holidays, in affiliation with Section H of the American Association for the Advancement of Science.

The chair appointed a committee on nominations consisting of Boas, Lowie, Swanton, Gordon and MacCurdy, whose report was accepted by the association, the election of officers resulting as follows:

President—Roland B. Dixon, Harvard University.

Vice-president 1914—George A. Dorsey, Field Museum of Natural History.

Vice-president 1915—Alexander F. Chamberlain, Clark University.

Vice-president 1916—A. L. Kroeber, University of California.

Vice-president 1917—George B. Gordon, University of Pennsylvania.

Secretary—George Grant MacCurdy, Yale University.

Treasurer—B. T. B. Hyde, New York.

Editor—F. W. Hodge, Bureau of American Ethnology.

Associate Editors—John R. Swanton, Robert H. Lowie, and Alexander F. Chamberlain.

The following is a list of the addresses and papers presented:

"The Piltdown Skull," by Charles H. Hawes.

"Ten Days with Dr. Henri Martin at La Quina (Charente), France," by Charles Peabody.

"Paleolithic Art as represented in the American Museum of Natural History, New York," by George Grant MacCurdy.

"The So-called 'Argillites' of the Delaware Valley," by N. H. Winchell.

"Results of an Archeological Survey of the State of New Jersey," by Leslie Spier.

"The So-called Red Paint People Cemeteries of Maine," by Warren K. Moorehead.

"Stone Implements of Surgery (?) from San Miguel Island, California," by H. Newell Wardle.

"Etruscan Influence in West Africa and Borneo," by Earnest Albert Hooton. (By title.)

"Brief Account of Recent Anthropological Explorations under the Auspices of the Smithsonian Institution and Panama-California Exposition," by Ales Hrdlička.

"Results of Excavations at Machu Picchu," by Hiram Bingham.

"The Human Monster-figure on the Nazca Pottery," by Edward K. Putnam.

"Note on the Archeology of Chiriqni," by George Grant MacCurdy.

"The Maya Zodiac at Acanceh," by Stansbury Hagar.

"Chinese Antiquities in the Field Museum," by Berthold Laufer.

"Some Aspects of North American Archeology," presidential address, by Roland B. Dixon, followed by a symposium: "The Relation of Archeology to Ethnology," by Franz Boas, W. H. Holmes, Berthold Laufer, George Grant MacCurdy.

"The Horse and the Plains Culture," by Clark Wissler.

(a) "Wayside Shrines in Northwestern California"; (b) "Is there Evidence, other than Linguistic, of Relationship between the Northern and Southern Athapascans?" by P. E. Goddard.

"Phratries, Clans, Moieties," by Robert H. Lowie.

"The Social, Political and Religious Organization of the Tewa," by H. J. Spinden.

"Tewa Kinship Terms from the Village of Hano, Arizona," by Barbara Freire-Marreco. (By title.)

"The Cnltural Position of the Plains Ojibway," by Alanson Skinner.

"Results of Some Recent Investigations Regarding the Southeastern Tribes of the United States," by John R. Swanton.

(a) "Notes on Alonquian Grammar"; (b) "Notes on the Social Organization of the Fox Indians," by Truman Michelson.

"My Experiences in the South Seas," by A. B. Lewis. (By title.)

"Field Work Among the Pagan Tribes of the Philippines," by Fay Cooper Cole.

"The Sac-sac or Human Sacrifice of the Bagobo?" by Elizabeth H. Metcalf.

"The Boomerang ln Ancient Babylonia," by James B. Nies.

(a) "The Huron and Wyandot Cosmogonic Deities and the Iroquoian Sky Gods"; (b) "The Wyandot Ukis," by C. M. Barbeau.

"The Clan and the Maternal Family of the Iroquois League," by A. A. Goldenweiser.

"Daily Life of the Southern Pai-Utes Forty Years Ago," by Frederick S. Dellenbangh.

"The Physical Type of the Burusheki of the Northern Himalaya," by Roland B. Dixon.

"The Eruption and Decay of the Permanent Teeth," by Robert B. Bean. (By title.)

"A Piebald Family of White Americans," by Albert Ernest Jenks.

"Condition Favoring the Development of Totemic Organization," by Franz Boas.

"Outline of the Morphology and Phonetics of the Keresan Dialect," by J. P. Harrington. (By title.)

"The Relation of Winnebago to Plains Culture," by Paul Radin. (By title.)

"Types of American Folk Songs," presidential address, by John A. Lomax.

"A Folk Dance from the Charente, France," by Charles Peabody.

"The Crow Sun Dance," by Robert H. Lowie.

"Notes on the Folk-Lore and Mythology of the Fox Indians," by Truman Michelson.

"Iroquois Totemic Complex," by A. A. Goldenweiser.

"Home Songs of the Tewa Indians," by H. J. Spinden.

"The Ballad in South Carolina," by Reed Smith.

"Negro Lore in South Carolina: (a) Tales, Sayings and Superstitions; (b) Songs, A Plantation Dance befo' de War," by Henry C. Davis.

"The Bridge of Sunbeams," by Phillips Barry.

"The Japanese New Year," by Mock Joya.

(a) "Siuslauan, a Newly Discovered Linguistic Family"; (b) "An Ethnological Sketch of the Wailatpuan Tribes of Northeastern Oregon," by Leo J. Fractenberg. (Both by title.)

"Some Aspects of the Folk-lore of the Central Algonkin," by Alanson Skinner.

"An Introduction to the Study of Indian Religion," by Paul Radin. (By title.)

George Grant MacCurdy,
Secretary

SCIENCE

FRIDAY, FEBRUARY 27, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE EVOLUTION OF A BOTANICAL PROBLEM

THE HISTORY OF THE DISCOVERY OF SEXUALITY IN PLANTS[1]

FROM the beginning of man's thoughtful consideration of natural processes, the phenomenon of sexual reproduction, with the associated phenomena of heredity, have persistently engaged his keenest interest. The primary fact of the necessary concurrence of two individuals in the production of offspring was, in the case of animals, recognized from the beginning. The equivalent phenomenon was not established for plants until the end of the seventeenth century. At this time, however, little more was known of the essential features of the sexual process in animals than had been familiar to Assyrians, Egyptians and Greeks twenty centuries before.

Of the additions made since 1700 to our knowledge of sexual reproduction, of its varied types and of the associated phenomena, no mean share has been contributed by botanical investigators. Noteworthy among such contributions are the work of Koelreuter and Mendel in the production and systematic study of plant hybrids, and the early work of Pfeffer on the chemotactic response of spermatozoids. Of more recent work we may cite that of the plant cytologists on apogamy and apospory, on multi-nucleate sexual cells or gametes, and on the long-delayed nuclear fusion in the sexual reproduction

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, December, 1913.

of the plant rusts. It should then be of interest for us to consider just how and when the more important steps have been taken in building up the vast mass of somewhat incomplete knowledge that we now possess concerning the reproductive process in plants. Because of exigencies of time and patience, I shall confine myself primarily to an attempt to picture the chief steps by which our present knowledge of the essential sexual process, the union of two parental substances, has been attained. Incidentally we may note the changes in point of view of investigators and in their mode of attack on this problem. I shall attempt to suggest the trend of development more clearly by often grouping the chief phenomena discovered in such a way as to indicate the sequence of discovery, within each group, of the different phases of the sexual process, though the order of discussion may thus not always accord with the sequence, in time, of the discovery of individual phenomena in plants as a whole.

In following the evolution and change in aspect of our problem we shall often find it best to keep a few relatively great names prominent. This will serve in the first place to make the story more vivid and intelligible. It will at the same time often come nearer the essential truth, for in each great forward step some one worker has usually been the dominating leader.

I. THE DISCOVERY THAT POLLINATION IS A PREREQUISITE TO SEED-FORMATION. 750 B.C. TO A.D. 1849

The first discoveries pointing to the existence of sex in plants were evidently made very early in human history by peoples cultivating unisexual plants for food. The existence of fertile and sterile trees of the date palm, *e. g.*, was known to the peoples of Egypt and Mesopotamia from the earliest times. Records of the cultivation of these trees and of artificial pollination have come down to us on bas-reliefs from before 700 B.C. found in the palace of Sargon at Khorsabad (Haupt and Toy, 1899). The Assyrians, it is said, commonly referred to the two date trees as male and female (Rawlinson, 1866). The Greeks, in spite of their peculiarly keen interest in natural phenomena, failed to offer any definite interpretation of this well-known fact concerning the date palm. Aristotle and Theophrastus report the fact, gained apparently from the agriculturalists and herb-gatherers, that some trees of the date, fig and terebinth bear no fruit themselves, but in some way aid the fertile tree in perfecting its fruit. But without recording a single crucial experiment on the matter, Theophrastus concludes that this can not be a real sexuality, since this phenomenon is found in so few plants.

In this uncertain state the knowledge of sexuality in plants was destined to rest for twenty centuries, waiting for the experimental genius of Camerarius to give a conclusive answer to the question raised by the Assyrian and Greek gardeners and answered wrongly by Theophrastus. The English physician Grew (1676) did, it is true, accept and expand the suggestion of Sir Thomas Millington that the stamens serve as the male organs of the plant. Thus Grew concludes (p. 173) that when the anther opens the "globulets in the thecæ act as vegetable sperm which falls upon the seed-case or womb and touches it with prolific virtue." But this guess, though it proved correct in the main point, was still a guess, and not supported by any critical evidence so far as recorded by Grew. The only adequate evidence that could be obtained on this question, while microscopes and technique were still so imperfect, was experimental evidence. This kind of proof

was first given, some 20 years after Grew's work, by Rudolph Jakob Camerarius, of Tübingen. Camerarius fully appreciated the presence of a real problem here. He also had the genius to see that the philosophical attempts of many of his immediate predecessors, to discover its solution entirely in their own inner consciousnesses, were futile. With the insight of a modern experimenter Camerarius put the question to the plants themselves. The results of his experiments, as reported in the famous letter of 1694 to Professor Valentin, of Giessen, were clear and conclusive. After noting that aborted seeds were produced by isolated—and therefore unpollinated—female plants of *Mercurialis*, and of the mulberry; by castrated plants of the castor bean; and by plants of Indian corn from which he had removed the stigmas, Camerarius gives his interpretation of these phenomena. He says (Ostwald "Klassiker," p. 25):

> In the vegetable kingdom there is accomplished no reproduction by seeds, that most perfect gift of nature, and the usual means of perpetuating the species, unless the previously appearing apices of the flower have already prepared the plant therefor. It appears reasonable to attribute to these anthers a *noble name* and *the office of male sexual organs*.

In the seventy years after Camerarius had proved in this way the existence of two sexes, and the fertilizing function of the pollen in plants, little advance was made. Bradley, of London, Gleditsch, of Berlin, and Governor Logan, of Pennsylvania, confirmed parts of Camerarius's work, and the great Linnæus accepted the conception of the stamens and pistils as sexual organs as clearly proven, *not, be it noted, by the results of Camerarius's experiments* but by *"the nature of plants."*

In 1761, J. G. Koelreuter, of Carlsruhe, published an account of the first systematic attempt that had been made, with either plants or animals, to produce and carefully study artificial hybrids. In his work with hybrid tobaccos, he demonstrated that characters from both parents are often associated in a single offspring. He thus not only completed Camerarius's work, but also, by showing that the male parent participates in the makeup of the offspring, he helped materially to break down the "emboitement theory" of Christian Wolff, which assumed that the embryo came entirely from the egg, and that its characters could not be influenced by the male parent. It is true that Koelreuter was mistaken in believing that fertilization is accomplished by the mingling of the oil on the pollen grains with the secretion of the stigma to form a mixed fluid, which he supposed then penetrated to the ovule. Nevertheless, his conception of the mingling of two substances was a move with the proper trend.

Koelreuter also demonstrated that in nature the pollen necessary to fertilization is often brought to the stigma by insects. He thus opened up a field of research which was cultivated with such splendid effect by Konrad Sprengel thirty years later, and by Darwin, Müller and others a century afterward.

In spite of the absolutely conclusive work of Camerarius, Koelreuter and Sprengel on the sexuality of plants, their conclusions were often rejected during the first half of the nineteenth century. Certain devotees of the nature philosophy, for example, occupied themselves either in proving over again, after Cesalpino, that plants can not be sexual, *because of their nature*, or in trying, by ill-conceived, and carelessly performed "experiments," to prove the conclusions of Camerarius and Koelreuter erroneous. These objectors were finally silenced, however, when Gaertner, in 1849, published the results of such a large num-

ber of well-checked experiments, entirely confirming the works of Camerarius, Koelreuter and Sprengel, that no thinking botanist has since doubted the occurrence in flowering plants of a sexuality essentially identical with that found in animals.

II. THE DISCOVERY OF THE POLLEN TUBE AND ITS RELATION TO THE ORIGIN OF THE EMBRYO, 1823–1847

During the opening years of the nineteenth century a number of botanists, who believed in the sexuality of plants, tried to discover by the aid of the microscope just how fertilization is effected. Most botanists of the day believed the pollen grain burst on the stigma, and that its granular contents found a way through the style to the ovary. An entirely new aspect of the problem of fertilization was opened up, however, when in 1823 Amici, of Modena, saw on the stigma of *Portulacca*, young pollen tubes arising from the pollen grains. Seven years later he followed these tubes through the style to the micropyle of the ovule. At about this time also, Jakob Matthias Schleiden (1838) took up the study of this same problem. He was a man of vigorous intellect and great versatility, who sometimes misinterpreted what he saw, but who proved a most stimulating opponent to a number of other workers who did observe accurately. After denying Robert Brown's assertion that the pollen tubes of the orchids arise in the ovary, Schleiden proceeded to describe and figure the pollen tube as penetrating, not merely the style and then the micropyle, but even far into the embryo sac itself.

Here, as he says in his Grundzüge (II., p. 373):

> The end (of the pollen tube) soon swells, either in such a way that the vesicle arising in it fills the whole cavity of the portion of the tube within the embryo sac, or there is left, between the apex of the embryo sac and the embryonal vesicle of the tube, a long or a short cylindrical portion of the latter, the suspensor.

He thus regarded the embryo sac as a sort of hatching place for the embryo which he thought formed from the end of the pollen tube. This idea of the origin of the embryo really denied the occurrence of any actual sexual process, and made the pollen the mother of the embryo.

In 1846, however, the error of this conception was clearly demonstrated by Amici, who showed that the embryo of the orchids arises from an egg which is already present in the embryo sac when the pollen tube reaches it. It is this pre-existing egg, according to Amici, that is stimulated to form the embryo by the presence near it of the pollen tube. This view was confidently supported by Mohl (1847) and Hofmeister (1847) in the following year, and the controversy with Schleiden became even more spirited. As Mohl afterward wrote (1863), men were "led astray by their previous conceptions to believe they saw they could not have seen." The dispute even approached the acrimonious, as when Schleiden (1843) says of one worker's figures, "Solche Praparate sind ohne Zweifel aus den Kopf gezeichnet."

Hofmeister, from the beginning of his study of fertilization in seed plants, had sought in the pollen tube for some equivalent of the spermatozoids, those motile male cells of the mosses and ferns that had first been understood by Unger in 1837. He was unable, however, to do more than point out the mistake of earlier observers in regarding the starch grains of the pollen tube as spermatozoids, and to suggest the likelihood that these motile cells might be discovered in the gymnosperms, a prediction the fulfilment of which was realized by Ikeno and Webber fifty years later. In his study of pollen tubes Hofmeister

demonstrated to his own satisfaction that the tube does not open in accomplishing fertilization. His view, which was the one current till 1884, was that the egg is stimulated to develop into the embryo by some substance that diffuses through the *imperforate* wall of the pollen tube.

III. THE DISCOVERY OF A PROTOPLASMIC FUSION AT FERTILIZATION

We come now to consider a series of discoveries of supreme importance in the investigation of the essential sexual process in plants. This is the period in which the problem that had baffled naturalists for twenty centuries was at last solved, at least in one most essential feature, by the demonstration of the occurrence at fertilization of a mingling of paternal and maternal substances.

It will not be without interest at this point to note the intellectual stimuli which led an unusual number of workers to investigate this phase of our problem.

In the first place there were on record, and under discussion at the middle of last century the many puzzling observations of the "Spiral Faden," or animalculæ, as they were thought to be, that had been found arising from a number of plants. These motile, spiral filaments had been seen in a liverwort (*Fossombromia*) by Schmiedel (1747), in *Sphagnum* by Esenbeck (1822), in *Chara* by Bischoff (1828), and finally, on the fern prothallus by Naegeli (1844). Unger (1834–37) studied these bodies in the mosses (*Sphagnum* and *Marchantia*) and declared his belief that they are not infusoria, but are the male fertilizing cells. At this time also the zoologists of the day were making the first detailed studies of the spermatozoa of animals. Barry (1844) had seen a spermatozoon within the egg of the rabbit; Leuckart (1849) saw them enter the frogs' egg and then, in 1851, Bischoff and Allen Thompson proved that fertilization is accomplished by the actual entrance of the spermatozoon into the egg. A no less important influence, in stimulating the botanical workers on the problem of fertilization, was the magnificent work of Hofmeister, on the reproductive structures of the mosses, ferns and conifers. By these splendid researches he had indicated to men of less insight, and less comprehensive imagination, just the points in the life cycles of plants where the critical phases of the reproductive process are to be sought.

Among the many workers engaged on this problem of fertilization in plants in the third quarter of last century there was, in consequence of readier exchange of information, an attitude of greater consideration for the work of other investigators than was found in the two preceding decades. There were differences of opinion and interpretation, to be sure, but there was less of that strenuous cocksureness when men saw, or thought they saw, differently from others. The mistakes of the brilliant Schleiden were perhaps remembered. Men like Hofmeister, Pringsheim and Strasburger added to and modified the interpretations of other workers in the same spirit with which they remolded their own immature conclusions. There was a spirit of cooperation evident; it became possible for a worker to observe and record the fate of a pollen tube in good temper and with calm judgment.

The first steps toward the demonstration of a union of two masses of living substance at fertilization resulted from the study of a group of plants, the algæ, in which sexuality had not been proven or generally admitted. It had, however, long before, been suggested in the case of *Spirogyra* by Hedwig (1798) and Vaucher (1803).

The algæ were in fact especially advan-

tageous for the study of fertilization, since the development and behavior of the reproductive organs and cells could, without elaborate preparation, be readily seen under the microscope, and often followed through in living material. Thus, Thuret in 1853 for the first time saw the active sperms attached to the egg of *Fucus*, and in 1854 proved experimentally that only eggs to which spermatozoids have had access will germinate. He thus demonstrated in this alga the correctness of Unger's unsubstantiated surmise (1837) that the spermatozoids are the male fertilizing cells. In *Œdogonium*, Pringsheim, in 1856 (p. 9), watched the spermatozoid push into the receptive tip of the living egg and saw the characteristic oospore wall formed in consequence. This, except for the less satisfactory observations made on *Vaucheria* by the same worker a year previous, is the first case recorded of the observation of the actual union of male and female cells in any plant. Such a union of the protoplasmic masses of the two sexual cells was soon shown to be a characteristic feature of fertilization in a number of algæ. Thus de Bary saw it in *Spirogyra* (1858), and Pringsheim (1869) repeatedly observed the gradual fusion of the motile gametes of *Pandorina*. It was nearly thirty years later, however, that this phase of fertilization was first seen in seed-plants by Goroschankin and Strasburger.

The workers on this problem were on the lookout for further details of the process of fusion, and even knew rather definitely what they were looking for, but failed to discover it from lack of proper methods of preparation of material. Thus, *e. g.*, Strasburger, in 1877, carefully studied the process of conjugation in *Spirogyra* and found that "Hautschicht fuses with Hautschicht, Kernplasma with Kernplasma"—"The chlorophyll bands unite by their ends"—and then goes on to say of the feature that evidently interested him most, "the cell nuclei of both cells, however, become dissolved; the copulation product is without a nucleus." Two years later, Schmitz (1879), when studying hematoxylin-stained material of this alga, was more fortunate. He saw the two nuclei in the zygote, as he says, "approach nearer and nearer, come into contact and finally fuse to a single nucleus." This observation by Schmitz is an important one, for in it we have the first clear statement that the nucleus of the male cell passes over intact to the female cell, there to fuse with the female nucleus.

Strasburger had, it is true, seen a second nucleus fusing with that of the egg in the archegonia of *Picea* and *Pinus* in 1877. He did not, however, really know the source of this second nucleus, though he suspected some relation to those that are present earlier in the tip of the pollen tube. These tube nuclei he says are dissolved just before fertilization, and then just after fertilization, to quote (1877):

> The male nucleus *formed from the contents of the pollen tube* is found now near the end of the tube, now near, or in contact with, the egg nucleus. . . . The protoplasmic contents of the pollen tube, I hold, passes through the (imperforate) tube-membrane in a diosmotic manner.

The fertilization of the gymnosperms, because of their large eggs, pollen tubes and nuclei, was then being studied by a number of workers. One of these, Goroschankin, in 1883, was able to demonstrate that in *Pinus pumilio* the pollen tube opens at the end, and that through this pore the two male cells pass bodily into the egg. Goroschankin's mistake, in supposing both male nuclei to fuse with the egg nucleus, was corrected by Strasburger the following year. The latter (1884) saw the same bodily exit of both male nuclei from the *open* pollen tube of *Picea*, but found only

one male nucleus fusing with that of the egg. In the same publication Strasburger also records numerous instances in which he had been able to observe the same mode of escape of the contents of the pollen tube into the ripe embryo sac in angiosperms. At last, as Strasburger puts it, in discussing fertilization in the conifers:

> The most important morphological facts are clear. It is established that the male nucleus that copulates with the egg nucleus, passes *as such* out of the pollen tube into the egg.

Thus, finally, was the actual material contribution of both parents to the embryo of the seed plants first seen. This was just two centuries, lacking a decade, after Camerarius (1694) had proven that the presence of pollen on the stigma is indispensable to seed formation. One chief reason why this important problem so long baffled all investigators was the lack of proper methods of preparing material for study. The older method of studying unfixed and unstained sections had certain advantages, it is true. The sequence of developmental stages was often determined with certainty by actually following their succession in living material under the microscope, and there was less cause also for dispute about artifacts. But structures of the same refractive qualities were not readily distinguished in such sections. As Strasburger himself says (1884, p. 18):

> The negative results of my earlier studies and of those of Elfving were due to the lack of a method which permitted the nuclei to be distinguished in the strongly refractive contents of the pollen tube up to the moment of fertilization.

That these studies of 1884 were successful was largely due to the use of material fixed in five-tenths-per-cent. acetic acid, one-per-cent. osmic acid or absolute alcohol, and stained in borax carmine, hematoxylin or iodine green.

The extreme significance of the fact that those most highly organized portions of the cell substance—the nuclei—were so prominent in the process of fertilization was at once appreciated by Strasburger, who in 1884 (p. 77) announced the following general conclusions as the outcome of his consideration of the phenomena observed:

> (1) The fertilization process depends upon the copulation with the egg nucleus of the male nucleus that is brought into the egg, which is in accord with the view clearly expressed by O. Hertwig. (2) The cytoplasm is not concerned in the process of fertilization. (3) The sperm nucleus like the egg nucleus is a true cell nucleus.

In the years since 1884 the nuclei have been found to be the structures chiefly concerned in fertilization whenever such a process occurs. Among the earlier observations of this nuclear union at fertilization in each of the great groups are the following, named in the order of discovery: It was seen in *Pilularia* (Campbell, 1888), in *Riella* (Kruch, 1891), in *Œdogonium* (Klebahn, 1892), in the plant rusts (Dangeard and Sapin-Trouffy, 1893), in the toad-stools (Wager, 1893), in the red alga *Nemalion* (Wille, 1894), in *Sphærotheca* (Harper, 1895), in the rockweed, *Fucus* (Farmer and Williams, 1896). Finally Zederbauer (1904) reported it for the Peridineæ and Olive (1907) and Kraenzlin (1907) made it out in the myxomycetes.

The observations just referred to, and many others on plants in all groups, warrant the general application of Strasburger's conclusion that a nuclear union is the characteristic feature of every sexual process. The few cases where the male cytoplasm seems more prominent than usual, as in the three conifers studied by Coker (1903), Coulter and Land (1905) and Nichols (1910), can not yet be said to have rendered it very probable that this cytoplasm plays a primary part as an inheritance carrier.

IV. THE DISCOVERY OF THE ALTERNATION OF GENERATIONS IN PLANTS, 1851–

The fact that the sexual cells of the higher plants are produced on a plant body or individual distinct from that which forms the asexual reproductive cells; and that in the normal life cycle the one type of individual arises from, and later gives rise to, an individual of the other type, must be regarded as one of the most significant features of the evolution of plants yet discovered. One of the chief general results of the magnificent work of Hofmeister was the discovery of this regular alternation of a sexual and an asexual generation, not only in the life history of the mosses and ferns, but also in that of the seed plants. Hofmeister states this result clearly in the *Vergleichende Untersuchungen* and makes it apply still more broadly in a brilliant generalization published in the "Higher Cryptogamia." There he says (p. 439):

> The phenogams, therefore, form the upper terminal link of a series, the members of which are the Coniferæ and Cycadeæ, the vascular cryptogams, the Muscineæ and the Characeæ. These members exhibit a continually more extensive and more independent vegetative existence in proportion to the gradually descending rank of the generation preceding impregnation, which generation is developed from reproductive cells cast off from the organism itself.

Since Hofmeister's day detailed investigations by many workers have fully confirmed Hofmeister's conclusion. They have shown the essential homology, not only of the spore-producing organs, and the one or two kinds of spores produced in them, but also of the structures arising from these spores, throughout all cormophytes, from the mosses upward.

In the studies of the algæ that followed immediately after Hofmeister's work, investigators of these plants sought in them for some evidence of that regular alternation of sexual and asexual phases that had been demonstrated in higher plants. Pringsheim (1856, p. 14) one of the ablest of these students of the algæ, at first regarded the multicellular body, formed at the germination of the oospore of *Œdogonium* and *Coleochæte*, as an asexual phase, comparable with the simple sporophyte of the liverwort *Riccia*. Celakowsky (1886) distinguishes as *homologous alternation* those cases, in algæ, like *Ulothrix* or *Œdogonium*, where the gamete-producing generation seemed capable of zoospore production also. The constant and regular alternation of the archegoniates and seed plants he called *antithetic alternation*. Pringsheim (1877) found that moss protonemata form from cuttings of the seta of the sporophyte as well as from bits of the gametophyte. From this fact, and from Farlow's discovery (1874) that a sporophyte of the fern, *Pteris cretica*, may arise directly from the prothallus, without the fertilization or even the formation of an egg, Pringsheim concluded that both generations of the archegoniates are really identical. He says (1877, p. 6):

> I believe the moss sporogonium stands to the moss plant in the same relation that the sporangium-bearing *Saprolegnias* do to the oogonium-bearing plants of this species, . . . I therefore turn against this interpretation of the fruit generation of the thallophytes in general, and especially against this interpretation of the sexual shoot generation of the Florideæ and Ascomycetes. . . . The cystocarp is evidently not a *separate* individual but part of the sexual plant that produces it.

The antithetic view was reasserted, however, especially by Celakowsky (1877) and Bower (1890), both of whom emphasized the suggestion of A. Braun (1875) that the sporophyte is a new thing phylogenetically. Bower holds that the types of sporophyte found in the archegoniates have arisen by the amplification of the zygote, with the sterilization for vegetative functions of

smaller or larger portions of the originally all-pervading sporogenous tissue. The amphibious type of alternation of the mosses and ferns has arisen, according to Bower's conception, with the migration of these plants to the land, and the assumption of the terrestrial habit by the sporophyte. The antithetic view was also supported in a most striking way, later, by the results of the workers on chromosomes.

The homologous view of alternation also has not been without supporters in the years since Pringsheim. One of its upholders, Klebs (1896), based his belief on the fact that he could determine the type of reproductive cells formed by the algæ *Hydrodictyon* and *Vaucheria*, by changing the conditions under which they are grown. Lang (1896–98) favored the homologous view because of the discoveries of Farlow, de Barry, Bower, Farmer and himself on apogamy and apospory. Scott, one of the strongest advocates of the homologous alternation theory, bases his belief not only on the evidence afforded by the cases of apogamy and apospory, but also on the fossil record. He points out the lack of any sporophyte, living or fossil, that can be regarded as ancestral to that of the ferns. In arguing for the homologous origin of the leafy fern sporophyte from a liverwort-like thallus Scott says (1911):

> We know plenty of intermediate stages between a thallus and a leafy stem; but no one ever saw an intermediate stage between a sporogonium and a leafy stem.

V. THE DISCOVERY OF CHROMOSOME REDUCTION AND OF SYNAPSIS, 1888–

We have seen that during the two decades at the middle of last century students of sexuality in plants devoted their attention to the discovery of the relation of the pollen tube to the origin of the embryo. The three decades after 1860 were given largely to the proof of a union of a paternal with a maternal nucleus as a constant feature of the sexual process in plants. For the past two decades workers interested in reproduction have been engaged especially in determining the behavior and fate, in the various phases of plant development, of those essential elements of the nuclei, the chromosomes. The result of this study has been to give us a much more definite criterion than we had before, of just what constitutes a sexual process. Moreover, this intimate examination of the chromosomes, together with the precise means of germinal analysis by breeding, introduced by Mendel, has given us some insight into the significance of the sexual process in the ontogeny and phylogeny of plants.

The discovery of chromosomes in plants may best be attributed to Strasburger, who, in 1875, first figured them distinctly in the embryo of *Picea*. It is true that Hofmeister (1867) had noticed the equatorial plate of "albuminous clumps" in cells at the time of their division, and Russow (1872) saw, in the dividing spore mother-cell nuclei of *Ophioglossum*, plates of vermiform rods ("Stäbchenplatten"). Strasburger (1879) and Hanstein (1880) and Flemming (1880) were, however, the first to realize the constancy of the occurrence of chromosomes in the dividing plant nucleus. The fact soon pressed itself upon investigators that the number of these chromosomes differs in different plants, and in different phases of the same plant. Then followed the epoch-making discovery of the zoologist Van Beneden (1883), that the number of chromosomes in the egg and sperm of *Ascaris* is the same, and that the double number characteristic of the body cells becomes reduced during the maturing of the germ cells. Botanists after some delay, due, as Strasburger says, to lack of proper technique, succeeded in demonstrat-

ing these same facts for plants. Thus Strasburger in 1888 showed that the number of chromosomes characteristic of the egg and of the male nucleus in a number of angiosperms is the same, and is fixed by a reduction, occurring in the mother cells of the pollen and of the embryo-sac. Guignard also (1889 and '91) demonstrated these phenomena in *Lilium* and in the pollen mother cells of *Ceratozamia*, noting the eight double chromosomes in the latter and other peculiarities of the first mitosis. Overton (1893) counted the same number of chromosomes in the female prothallus of *Ceratozamia;* while Farmer (1894) found four chromosomes in the thallus and sexual reproductive cells of *Pallavicinia* and eight in the seta and capsule.

Later in the same year Strasburger, in a masterly address before the British Association, completed the proof of Overton's suggestion (1893) that reduction in the mosses and ferns also takes place, as Overton puts it, "in the mother-cells of the spores; that is, at the point of alternation of the generations." Strasburger, by comparing his counts of chromosomes in the dividing spore mother cells of *Osmunda*, with the number seen by Humphrey (figures published in 1895) in the tapetal cells, found the latter number about double. It is interesting to note also that the *Osmunda* slides used in this work were among the first paraffin sections used by Strasburger.

From this correspondence of the liverwort and fern mentioned with the seed plants in which reduction had been seen, Strasburger went on to predict the universal occurrence of this phenomenon of reduction in all plants that reproduce sexually. Concerning the phylogenetic origin of the reduction process Strasburger held that all plants (and animals) were primitively non-sexual and had a constant number of chromosomes. With the development of sexual reproduction the initiation of the process of chromosome reduction avoided the evident disadvantage of repeated doubling of the chromosome number at each sexual fusion. This return from the double number formed in the zygote to the primitive, ancestral number of chromosomes, he believed might occur at any point in the life cycle before the next fertilization. Strasburger then went on to emphasize the advantage of the sexual mode of reproduction, when once acquired, in allowing new combinations of parental strains in the offspring, and the disadvantage it had of producing so small a number of offspring. It is to meet this disadvantage, he suggested, in agreement with Bower, that the zygote of forms like *Coleochæte*, mosses, ferns and seed plants took over the function of multiplying the progeny by a sort of polyembryony, the formation of spores. The spore-bearing generation later in the evolutionary history became ultimately independent of the gametophyte, and at a still later period it not only produced two kinds of spores, but also assumed the care and nutrition of the reduced female plant, arising from the larger of the two kinds of spores. Thus, in Strasburger's view, the primitive non-sexual generation is now represented in the archegoniates by only the sexual phase which has gradually lost its power of asexual multiplication, while the sporophyte is a third, a new, generation arisen by specialization of the zygote. There is in the cormophytes then an antithetic alternation of the two most recently evolved phases of the life cycle, while the only clear trace of the primitive non-sexual phase is found in the halved number of chromosomes, which is reverted to by a process of chromosome reduction, at some point in each life cycle.

In the two decades since this famous pronouncement of Strasburger's was made

chromosomes have been counted in the different developmental phases of nearly all groups of plants. These counts have shown that wherever there is sexual fusion there is also, at some other point in the life cycle, a reduction of the double number of chromosomes so formed to the single number characteristic of the gametes. In all cormophytes and many thallophytes this reduction occurs at sporogenesis.

The investigation of the complementary phase of the chromosome behavior, the doubling of the number at fertilization, has during the past two decades also led to extremely interesting results.

The earlier workers on sexual nuclear fusion apparently believed that the paternal and maternal nuclear materials became intimately mingled soon after contact of the nuclear walls. Thus Klebahn (1892) described the chromatin reticula of the two nuclei as gradually merging into one, in *Œdogonium*, and Shaw (1898) described the same process in *Onoclea*. It is true that Guignard (1891) had noted that, in *Lilium* and *Fritillaria*, the male and female reticula remain distinct until the prophase of the first nuclear division of the embryo. Later research, however, showed that the paternal and maternal components remain distinct till much later than this; in fact, that the chromatin elements from the two parents do not really fuse at all during the process of fertilization. On the contrary, it is pretty certain that all through the development of the sporophyte the chromosomes from the two sources retain their identity and individuality.

Thus Blackman (1898) and Ferguson (1901) say that in the fusing nuclei of *Pinus* the two chromatin nets never lose identity, and that at the first mitosis of the embryo each constituent gives rise to its own group of chromosomes. This independence of the two chromatins at fertilization has since been seen in a number of species, and it is now believed to persist throughout the life of the sporophyte. The double number of chromosomes is present at each mitosis of this generation, and they sometimes occur in pairs that are assumed to consist of a paternal and a maternal chromosome each. In certain plants also, according to Overton (1909), Gregoire (1910), Stout (1912) and others, the individuality of the chromosomes of the resting nucleus, postulated by Strasburger in 1894, is morphologically discernible. De Vries (1903) emphasized this fact, that the sporophyte, with its two complete sets of chromosomes, is really two beings in one, by designating it as the "2*X* generation." This contrasts it at once, in this important characteristic of chromosome number, with the gametophyte or "*X* generation."

Apparently then no actual fusion of the chromosomes is included in the nuclear union occurring at fertilization. The question at once arising is: where in the life cycle is there any fusion, or intimate union of these inheritance-bearing units? The answer to this question was for some time generally believed to be offered by the phenomena associated with the process of "*synapsis*." Botanists had for some time noticed and figured the peculiar contraction of the chromatin of the spore mother-cell nucleus occurring just before the chromosomes for the reduction division are formed. Moore (1895) reaffirmed Strasburger's view that, even with the best preservation, the chromatin regularly assumes this condition at sporogenesis, and then only. Moore, therefore, declared this condition to be, not an artifact, as many workers had held, but a natural process, which he named "synapsis." In spite of the insistence by an occasional worker that synapsis is an artifact, the impression of its constancy and peculiarity grew more

general at the end of the last century. Then in 1901 Montgomery suggested that it is in this process that the long-delayed union of the paternal and maternal chromatin occurs. Montgomery's conception, that each of the double or bivalent chromosomes, formed on emergence from synapsis, is made up of a paternal and a maternal chromosome, which have in some way been paired up during the synaptic process, came to be rather generally accepted.

Recently, however, a number of workers have dissented vigorously from the view that synapsis is a constant, or a highly significant process. Thus Gregoire (1910), Gates (1911) and Lawson (1912) hold that it does not occur unfailingly at sporogenesis. Lawson says that so much of the separation of the chromatin from the nuclear wall as is not due to artifact is attributable to the more rapid growth of the nuclear wall than of the chromatin. Finally all three agree that such a process is not needed for the pairing of the chromosomes, since, as was observed by Strasburger (1905) and others, the chromosomes may regularly appear in pairs in the vegetative mitoses of the sporophyte. Moreover studies of the vegetative nuclei of the sporophyte, especially by Gregoire and his students, show that their chromosomes are closely connected by adhesions, and by pseudopodium-like strands developed between the viscid chromosomes when the new reticulum is formed after each mitosis. Gates (1911) after reviewing recent work on this point holds that the pairs seen in vegetative mitoses are of a paternal and a maternal chromosome each. He sees no adequate reason for thinking that the association of parental chromosomes at synapsis is any more intimate than that which occurs, as he says, "at or soon after fertilization." He evidently regards the connections between sporophytic chromosomes referred to above as affording ample opportunity for any interchange of material or "influences" between the chromosomes. Gates does not say just when the parental chromosomes are first paired up after fertilization nor give the evidence for this. He fails, also, to explain the fact, upon which practically all workers seem agreed, that the halves of the diploid chromosomes are associated with each other in a more intimate way than the chromosomes of any other mitosis in the life cycle.

VI. ALTERNATION AND CHROMOSOME NUMBERS IN THE ALGÆ, 1896–

We have already seen that an attempt was made in the third quarter of last century to interpret the life histories of certain thallophytes, especially among the algæ, in terms of the alternating generations discovered by Hofmeister among the archegoniates. The basis of comparison was the occurrence of a sort of polyembryony at the germination of the sexually produced oospore of these algæ. There was much uncertainty, however, concerning the real correspondence of phases in the two groups, and even as to whether the alternation was of the same sort in the two groups.

With the promulgation of Strasburger's view (1894) regarding the significance of the reduction of the chromosome number in the life cycle, botanists felt that they would now be able to distinguish the phases of a real alternation of generations wherever chromosomes could be counted. A number of workers therefore followed out cytologically the details of development and conjugation of the sexual cells, and the germination of the zygote in various algæ.

The work of Chmielewski (1890), on *Spirogyra*, and of Klebahn (1891) on desmids showed some indications of a reduction process at the germination of the

zygote in these forms, though chromosomes could not be counted. Not till very recently was it demonstrated for one of these, *Spirogyra*, that the chromosome number is actually reduced at this time. Tröndle (1911) has counted chromosomes of *Spirogyra* and finds that there is a real reduction here, and that three of the first four nuclei formed in the zygote degenerate, the fourth remaining as the nucleus of the single embryonic plant formed.

In a study of the green alga, *Coleochæte*, Allen (1905) showed that the chromosome reduction occurs with the beginning of germination of the zygote. Hence the group of zoospore-producing cells, arising from the latter, is not to be regarded as a sporophyte, as had often been maintained. Allen thus eliminated the only ancestral prototype of the bryophyte sporogonium that the antithetic alternationists had been able to discover among the green algæ.

The search among the brown algæ for parallels to the chromosome history of the cormophytes has been much more successful. The first case made out, that of *Fucus*, by Farmer and Williams (1896) and by Strasburger (1897) seemed, it is true, not very illuminating. They found the reduction occurring in the first divisions of the eggs and sperm-producing organs, a point where it occurs in no other green plant. This case of *Fucus*, you will remember, is the one used by Scott (1896) to point a moral, when voicing the generally felt criticism of those botanists who proposed "making the number of chromosomes the criterion by which the two generations are to be distinguished." He says:

I venture to think it premature to rush into inductive reasoning from imperfectly established premises. The case of *Fucus* in which the *Fucus* plant is shown to have the full number of chromosomes goes dead against the idea that the sexual generation (and who could call a *Fucus* plant anything but sexual) necessarily has the reduced number of chromosomes. This fact is indeed a rebuff to deductive morphology.

When, however, Strasburger (1906) and Yamanouchi (1909) followed out the logical trend of the chromosome evidence unreservedly, this life history of *Fucus* became more readily comparable with that of the cormophytes and with those of certain brown and red algæ that had in the meantime been elucidated by Williams and Yamanouchi. From this point of view, elaborated by Yamanouchi, the *Fucus* plant with its $2X$ number of chromosomes is a sporophyte and the reproductive organs arising in its conceptacles are sporangia comparable with those of a seed plant. After the reduction, which occurs at the normal point, *at sporogenesis*, each of the four megaspores, without escaping, gives rise to a gametophyte of two fertile cells or eggs. Each of the four microspores in turn forms a gametophyte, or X generation, of but sixteen cells, each of which is fertile and forms a spermatozoid. It is interesting to note here the similarity which has been pointed out by Strasburger and by Chamberlain of the chromosome cycle of *Fucus* to that of animals. In the latter, from the plant cytologist's point of view, the sexual generation has become reduced to the four haploid nuclei formed at spermatogenesis and oogenesis; and the so-called ovary and spermary are really spore-producing organs of the $2X$ or asexual generation.

In the brown seaweed *Dictyota* the discovery of the chromosome cycle revealed, for the first time in any thallophyte, an alternation that seemed clearly comparable with that of the cormophytes in this respect. Williams (1904) was able to show that the morphologically similar, mature plants of *Dictyota dichotoma* differ not only in that some produce spores only and others male or female reproductive cells

only, but also that the nuclei of the former have twice as many chromosomes as those of the sexual plants. He found also that the number of chromosomes is reduced at tetraspore formation and held that all this cytological evidence indicated the alternation of the sexual and the tetrasporic plants. The doubts of conservative botanists regarding the regular and necessary sequence of these haploid and diploid plants were dissipated when Hoyt (1910) raised fruiting tetrasporic plants from eggs and mature sexual plants from tetraspores. Hoyt thus demonstrated, for the first time by cultures in any alga, the identity of this alternation with that of the cormophytes. Yamanouchi (1911 and 1913) has demonstrated, cytologically and in part by cultures, the occurrence of an exactly similar type of alternation in the brown algæ *Cutleria* and *Zanardinia*, the life cycle of *Cutleria* seeming peculiarly like that of the cormophytes because the two generations differ not only in chromatin content, but also in structure.

In the red seaweeds also the use of cytological methods and the determination of chromosome numbers has given a series of very suggestive, though not as yet easily interpreted, results. Oltmanns (1898) showed that the nucleus of the carpospore is a direct descendant of the diploid oospore nucleus. Wolfe (1904) decided that in *Nemalion*, a species that does not form tetraspores, the reduction occurs at the budding out of the carpospores from the mass of cells arising by division of the fertilized egg. He therefore follows Oltmanns in regarding the diploid cell mass mentioned as the sporophyte of this species. In a series of red algæ, which have a tetrasporic phase in the life cycle, Yamanouchi (1906), Lewis (1909) and Svedelius (1911) have demonstrated, cytologically, an alternation of two generations very similar in character to that first found in *Dictyota*. Lewis (1912) later proved conclusively by the use of cultures that the haploid sexual plants arise from tetraspores only, while the diploid fertilized egg gives rise, through the carpospores formed from it, to tetrasporic plants only.

In the interpretation of the phenomena seen in these red algæ Yamanouchi regards the tetrasporic plant as the more primitive phase of the $2X$ generation, and carpospore-formation as a sort of secondarily developed polyembryony for multiplying the progeny from each fertilization. Lewis's view, on the contrary, holds that the tetrasporic plant is, in origin, an early, self-propagative phase of the primitive, haploid, sexual generation. Further he suggests that, in accordance with a general tendency evident in many sexual plants, the process of reduction has here been postponed, and pushed forward from the time of carpospore-formation, where it still occurs in the primitive form *Nemalion*, into this originally haploid tetrasporic plant.

Though no generally accepted interpretation has yet appeared of the somewhat varying chromosome cycles that have now been elucidated in green, brown and red algæ, yet the mass of facts thus far obtained presents an impressive picture of the essential identity of reproductive processes in these plants with those found in the cormophytes. Perhaps the most interesting point noted in making such a comparison is the fact that the type of life cycle among algæ that corresponds most closely with that of an archegoniate, *e. g.*, is the type found in several genera of the brown algæ. The fact may be recalled here also that it was to the gametangia of this group that Davis (1903) finally turned in his search for a prototype of sexual reproductive organs of the bryophytes.

VII. SEXUALITY, CHROMOSOME HISTORY AND ALTERNATION IN THE FUNGI, 1820–

In this group of parasitic or saprophytic thallophytes we shall find as great a variety in the type of reproductive process as in their mode of nutrition at the expense of the hosts beset by them. At the beginning of last century fungi were commonly supposed to arise spontaneously "out of the superfluous moisture of the earth and rotten wood."

Observations had been made long before this, it is true, sufficient to render improbable the spontaneous generation of the fungi then commonly believed in. Thus Micheli (1729) had raised a fungus mycelium from spores. Ehrenberg (1820) did the same and also saw the conjugation of Sporodina. Du Trochet (1834) proved that the mushroom arises from threads of the mycelium in the soil.

The spontaneous generation of even the simplest of these parasitic or saprophytic thallophytes—the bacteria—had been denied by Leewenhock at the end of the seventeenth century. In one his numerous letters to the Royal Society he denies the spontaneous origin of the animalculæ or bacteria which he found in the mouth. These he found present even in the mouths of ladies who clean their teeth carefully! He insists that these organisms are like those he had found in pools of water, and then goes on to say, in a paragraph that reads like a modern health commissioner's report:

> Now when people wash their beer mugs and drinking cups in the water from ponds and streams, who can tell how many of these animalculæ may stick to the sides of the glass and thus get into the mouth.

The hazy or bizarre beliefs concerning the occurrence and the mode of reproduction in the fungi, current at the middle of last century, were dispelled by the studies of a group of able investigators early in the second half of the century. First came the splendid work of the brothers Tulasne (1847–1854) on the smuts and rusts, and their discovery of the oogonium of *Peronospora*. Pringsheim in 1857 studied the sequence in development of the zoosporangia and oogonia of the water moulds. Then came the researches of that master mycologist, Anton de Bary, on the reproductive structures of *Peronospora* (1861), of *Pyronema* and *Sphærotheca* (1863), and on the life histories of the rusts, 1853 and 1865. The results of his own work and that of his students Woronin and Janczewski convinced de Bary that, in the Ascomycetes, as well as in the phycomycetous *Peronosporas*, the contents of an oogonium is fertilized by the escape into it of the living contents of the antheridial tube that grows beside it.

In the seventies and eighties a vast number of detailed observations concerning reproductive processes in the fungi were accumulated by many observers, led especially by de Bary's student, Brefeld. One outcome of this work which concerns our particular problem, was the insistent, though unconvincing denial by Brefeld of the sexuality of the ascomycetes.

In the last decade of the nineteenth century, with the application of new methods of fixing, sectioning and staining, a new era opened in the study of sexuality in the fungi, an era in which American workers have played a prominent part from the beginning.

As early as 1886 Rosenvinge had succeeded in staining the many nuclei of the mycelial cells of toadstools, also the primary basidium nucleus, and the four spore nuclei arising from this.

Humphrey (1892) and Hartog (1895) followed the history of the nuclei in the antheridium and oogonium of *Saprolegnia*, by the use of stained sections, and con-

cluded, as de Bary had done, that there is no fertilization in these forms. Not until the work of Trow (1904) and Claussen (1908) was it proven that the antheridium of these water molds is sometimes functional, and not always vestigial as de Bary (1881) and Humphrey had thought.

The earliest cytological work on the ascomycetes, after the detection of their nuclei by Schmitz, was that of Dangeard (1894). He described and figured a fusion of two nuclei in the ascus of *Exoascus,* of *Peziza,* of the truffle and others. The source of the two fusing nuclei Dangeard did not trace back farther than the subterminal cell of a hooked hypha from which the ascus arises in *Peziza* and others. The ascus with its fusion nucleus he regarded as an oospore.

In 1895 there was announced from Strasburger's famous laboratory at Bonn a discovery which seemed at one stroke to settle the dispute between de Bary and Brefeld, and to definitely demonstrate the occurrence of a sexual nuclear fusion in the sexual organs seen by de Bary. In that year Harper showed that out of the opened antheridial tube of the hop mildew, *Sphærotheca,* a male nucleus passes into the oogonium and fuses with its nucleus. The whole behavior of antheridium and oogonium and their contents had every aspect of a real sexual process, as de Bary had asserted in 1863. What made Harper's discovery still more significant was the determination of the fate of the fusion nucleus in relation to the nuclei of the ascus and spores. Harper found that one of the row of 5 or 6 cells resulting from the division of the fertilized oogonium has two nuclei. These two descendants of the diploid nucleus, formed at fertilization, afterward fuse, and the cell containing them swells to form the single ascus of this species. This, presumably tetraploid, fusion nucleus of the ascus then grows and divides three times to give the eight spore nuclei. In the following year or two Harper (1896–97) demonstrated a sexual fusion of the same type at the initiation of the fruits of another mildew, *Erysibe,* and of the saucer fungus, *Ascobolus.* The *numerous* asci of these forms all arise from binucleate branches of the binucleate, subterminal cell of the fertilized oogonium. Each ascus is at first binucleate, but later, as had been seen by Dangeard (1894), the two fuse and then by division the eight spore nuclei are formed as in *Sphærotheca.*

In the course of the following decade Harper reported the occurrence of two nuclear fusions, like those of *Sphærotheca,* and at the same points in the life cycle, in the mildews *Erysibe* (1896) and *Phyllactinia* (1905), and in the saucer fungus *Pyronema* (1900). Moreover, he found in *Phyllactinia* a synapsis and evidences of a double reduction of the chromosome number in the divisions of the presumably tetraploid, fusion nucleus of the ascus. *Pyronema* proved interesting also in having multinucleate gametes, such as were at this time being studied by Stevens in the white rust, *Albugo.* Harper believed that many pairs of male and female nuclei fuse in the oogonium of *Pyronema.*

As the outcome of this whole series of studies by Harper it seemed clear that there is in many ascomycetes an alternation of a haploid generation, the vegetative mycelium, with a diploid generation, the fertilized oogonium and the ascus-forming hyphæ arising from it. The second fusion, in the ascus, was regarded as a nutritive phenomenon to provide a nucleus adequate in size for the organization of the relatively huge ascus.

At the opening of the century the observations of a number of workers on the simpler ascomycetes, *e. g.,* by Juel (1902),

Barker (1902), seemed to establish the occurrence of a nuclear fusion in the oogonium in these forms also. This, with Harper's, work made it seem probable that this fusion is a frequent phenomenon throughout the ascomycetes in general.

The researches of certain other cytological workers, however, convinced them that no fusion of nuclei really occurs in the oogonium of the ascomycetes studied by them. Thus Dangeard (1897 and 1907), working on *Sphærotheca* and *Erysibe*, found no fusion except that in the ascus. Claussen (1907) and Brown (1909) could find no other in the varieties of *Pyronema* studied by them. Both workers find paired nuclei associated in the ascogenous hyphæ and finally in the young ascus. Claussen, therefore, regards the fusion in the young ascus as a fusion of descendants of the sexual nuclei that were *brought together* in the oogonium but did not fuse there. In other words, he thinks it a real sexual fusion which has been deferred. Brown, on the other hand, says that in his plant no antheridial nuclei are concerned, since the antheridium never reaches the oogonium. He therefore regards the fusion of pairs of nuclei, derived from the oogonium, which occurs in the ascus, as one that serves as a substitute for the sexual fusion that primitively occurred in the oogonium. Brown's view is supported further by his work on *Lachnea* (1911), and by Faull's recent work (1912) on certain *Laboulbenias*.

If this view of Brown's be accepted it implies that the original diploid condition of the cells of the sporophyte has been altogether eliminated, except for the brief uninucleate stage of the ascus. In spite of this, however, the whole structure and development of the original $2X$ generation, from fertilized oogonium to mature fruit and ascus, has been retained. This same normal type of vegetative structure, in spite of an abnormal chromosome number, has been demonstrated in gametophyte and sporophyte of aposporous and apogamous mosses and ferns. It is implied also in Lewis's suggestion that, in the red seaweeds, the reduction has been postponed from its original location at carpospore-formation over into the primitively haploid tetrasporic phase of the next generation.

Still other recent work on the ascomycetes, however, supports Harper's view that a double fusion frequently occurs in the ascomycetes. Thus Blackman and Fraser (1906), Fraser (1907–08) and Fraser and Brooks (1909), find evidence of several degrees of loss of function of the antheridia in the different species of the cup fungi *Lachnea* and *Humaria*. In those cases where no antheridial nuclei are discharged into the oogonium, nuclei of this organ itself are believed, by these workers, to fuse in pairs within it. The later fusion in the ascus, which they find in common with all workers, they regard as a nutritive phenomenon.

Until toward the end of last century the basidiomycetes were generally assumed not to be sexual. At least no sexual organs had been described for them, with the exception of the spermagonia and æcidia of the plant rusts. These had been called male and female organs, respectively, by Meyen, before the middle of the century. The very first nuclear studies of the rusts and toadstools, however, revealed the occurrence of a nuclear fusion, and at another point in the life history, indications of the complementary process, a reduction, were discovered.

In the case of the rusts Rosen (1892) saw two nuclei in the æcidiospore of certain species. Dangeard and Sapin-Trouffy (1893) reported the occurrence of a nuclear fusion in the teleutospore. Sapin-Trouffy (1896) found that the cells of the æcidium-bearing mycelium are uninucleate up to the

very base of the chain of æcidiospores. Maire (1900) first stated clearly the whole nuclear cycle in rusts: Beginning with the binucleate æcidiospore there follows, in the wheat rust, *e. g.*, the uredo, or rust stage which has a binucleate mycelium and forms binucleate uredospores for several generations. The two nuclei of the young teleutospore, finally formed on this mycelium, fuse as the spore matures. The two divisions of this fusion nucleus in the promycelium give rise to the four nuclei of the four sporidia which germinate to the uninucleate cluster cup mycelium on the barberry. Maire saw in this life history a real alternation of generations, the gametophyte or X generation beginning with the sporidium, the sporophyte or $2X$ generation, with the mother cell of the æcidiospore chain.

Blackman (1904) and Christman (1905) discovered the origin of the binucleate condition of this mother-cell in species of *Phragmidium*. It there arises by the migration of a nucleus from one cell into another, or by the fusion of the cytoplasm of two cells to form the mother-cell of the spore chain. The two nuclei thus brought together divide simultaneously or conjugately, each contributing a nucleus to the first and to each succeeding spore. This conjugate division of the paired nuclei and their descendants was shown to occur all through the uredo generation up to the formation of the young teleutospore. In the interpretation of their discoveries Blackman and Christman differ more widely than in the facts reported. The former reasserts the surmise of Meyen and believes the basal cells of the spore chain are oogonia which were primitively fertilized by the now functionless spermatia, or pycnospores, produced in separate organs on the barberry leaf. Christman, on the contrary, regards the fusing cells at the base of the æcidium as the primitive, undifferentiated sexual organs of these fungi. He holds that male and female organs have never become differentiated in this group, and thinks that the spermatia are, or were, propagative cells of the X generation.

The observations of many workers on the smuts and on the toadstools have shown the frequent occurrence in them of an association of nuclei and the final fusion of two nuclei in the chlamydospore or the basidium. The time and mode of association of the fusing nuclei, or of their progenitors, are very different in different forms. The fusion, and what appears to be the reduction divisions are, however, constant in location in each species, and are always closely associated. Thus, *e. g.*, the nuclear fusion in the smuts often occurs in the chlamydospore, according to Dangeard (1893) and Rawitscher (1912), and reduction evidently follows immediately in the next developmental phase, when this spore germinates to form the sporidia. In the toadstools, according to Wager (1893), Dangeard (1894), Harper (1902), Nichols (1904) and Levine (1913), the fusion of nuclei occurs in the basidium, and the reduction at the very next division of this fusion product, when the four spore nuclei are formed.

The striking uniformity with which the apparent reduction occurs in all basidiomycetes, at the time of formation of the sporidia or basidiospores, affords good evidence that this type of spore-formation is a long-established one, common to the whole group. It thus supports Brefeld's view that the promycelium of the smuts and rusts is homologous with the basidium of the higher forms. That the point in the life cycle where the associated nuclei finally fuse is the point at which it occurred in the earliest basidiomycetes, is not so clear. The modes of bringing about the first association of the paired nuclei are so varied that

it is difficult to detect any clearly ancestral type among them all. The structures concerned with this process in the æcidium-forming rusts certainly seem most readily comparable with the reproductive organs of other thallophytes. It seems probable that the occurrence of fusion at the same point in all forms is due to its being postponed in all forms, as long as it could be without being pushed over into another phase of the life cycle.

It would be instructive to spend another half hour, as we can not do here, in considering those peculiar short cuts in reproduction known as apogamy and apospory. These phenomena are so patently secondary, and so relatively infrequent, that they can not be looked to for evidence of fundamental importance concerning the history or the significance of the essential sexual process itself. Their study has, however, served to correct certain false assumptions concerning the relation between the difference in chromosome number, and the difference in structure, of the two generations. For example, the apogamous production, by *Nephrodium molle*, of a normal fern sporophyte with the X number of chromosomes, demonstrates, as no other kind of evidence could, that de Vries was right in regarding the normal sporophyte as really two beings in one. Incidentally too, such phenomena suggest how comparatively unimportant it is, for the structure of the plant, in what manner, and at what point in the life history, the association of the $2X$ number of chromosomes is brought about.

CONCLUSION

In our rapid glance at the progress made in the study of this problem, during twenty centuries, we have seen how for eighteen centuries men attempted to solve the problem by recourse to philosophical reasoning, without the aid of detailed observation or experiment. Then, in less than two centuries, by the use of these means, Camerarius proved that pollination is a necessary condition of seed-formation; Koelreuter demonstrated that characters from both parents appear in hybrid offspring; Amici, Schmitz and Strasburger showed how the mingling of parental qualities is made possible by the approximation and fusion of parental protoplasms and nuclei.

The sexuality which was first suspected, and first experimentally proven, in the seed-plants, has now been demonstrated in all groups of plants save the bacteria and their allies. The primary feature of the process, the union of two parental nuclei, is the same in all. The method of bringing together the two nuclei varies widely, this variation sometimes involving even the complete disappearance of externally recognizable sexual organs. During the evolution of plants old methods of accomplishing the approximation of the nuclei have been discarded, and new methods have arisen. In the latter case a fusion of nuclei of closer kinship has often been substituted for the primitive one of more distantly related nuclei. This seems evidently the case, for example in the apogamous ascomycetes, perhaps also in the basidiomycetes, and surely so in the cases of nuclear fusion in the prothallia and in the sporangia of apogamous ferns.

In the process of fertilization, as we understand it at present, there are brought together two distinct sets of chromosomes, which in the nuclear divisions of the sporophyte, or $2X$ generation, are often found associated in pairs. The exact manner in which these chromosomes become paired, and the possibility of their attaining any more intimate association, either in the resting reticulum or in synapsis, are not yet definitely determined. If, as is indicated by Mendelian phenomena, and as is demon-

strated cytologically to the satisfaction of many workers, there is no loss of identity of the chromosomes in the sporophyte, then there is no very *significant* fusion at any point in the life cycle in consequence of the sexual process. Members of the two sets of chromosomes may be interchanged or shuffled, probably at synapsis, and thus new sets or combinations be formed in the haploid nuclei at reduction. These new combinations, however, are still made up of the same discrete individual chromosomes.

The essence of the sexual process then, as far as yet morphologically demonstrated, consists not of a real fusion, but merely of a temporary association, followed by a re-assortment at sporogenesis, of those ultimate, inheritance-bearing units—the chromosomes.

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DR. J. J. RIVERS

WITH the death of this aged naturalist in southern California last December, one of the last links joining the present with the beginning of modern science has been broken. Born in England in the early twenties of the last

century, his childhood days were those of Murchison and Lyell, the years of his young manhood those of Darwin, Dana and Hall, while Hugh Miller, Huxley and Tyndall were his contemporaries. His place in middle-class English life and the possession of private means made it unnecessary for him to devote himself to the practise of his profession, and his interest in the awakened spirit of research kept him busy in the fields of discovery during the half century of his life in England. His first contribution to science was a paper read before a society in Birmingham in 1840. The writer has in manuscript one of his lectures read before a similar body in London in 1863, with the names of Stafford, Hardin, Fay, Spence-Bate, Hodges and Scrivener, in the discussion on the evidences of the antiquity of man, in which he places this age conservatively at 100,000 years. This epitome of results attained a half century ago gives sufficient data to indicate his place in the thought of his time.

He was preeminently an entomologist, adding several new species to British Lepidoptera and Coleoptera. In this pursuit he was in personal touch with Darwin. He came to this country in 1868 and after a few years went to the Pacific coast. Here the Le Contes found him, and by their influence he was made curator of the museum in the University of California. While in this service it was said of him that his ability was sufficient for any office in the institution, even for its presidency. Under his guidance was trained a group of young students who have since won an honorable place as men of science.

He resigned when past seventy, and for twenty years was the Hugh Miller of the California coast, gathering insects and fossils all the way from San Diego to Santa Barbara. His collection of insects was purchased about ten years ago for the German Royal Museum in Berlin. His collection of Cenozoic marine fossils of over 200,000 specimens, classified by himself, was purchased for Beloit and Pomona Colleges, and forms an invaluable part of their illustrative material.

He lived his own life, neither seeking nor shunning publicity. To the world he was only a gray old man; to those whom he knew and cared for, the most delightful companion. He added about a score of species of insects and mollusks to the world of knowledge and something like the same number have received the name *riversii* in his honor. Without relatives, in an alien land, his life went out amid a small circle of very dear friends.

Ira M. Buell

Logan Museum, Beloit College,
Beloit, Wisconsin

THE FOURTH INTERNATIONAL BOTANICAL CONGRESS, LONDON, 1915

The second circular for the Fourth International Botanical Congress to be held at London, 1915, has been just received. As the time when motions and resolutions must be ready is short the circular is reprinted below entire, excepting that only the American members of the committees are mentioned.

The Nomenclature Section of the Third International Botanical Congress, held at Brussels in 1910, carried towards completion the work of the Vienna Congress (1905) on the international rules governing questions of nomenclature. The combined result of the decisions reached at Vienna and Brussels has been published in the second edition of the "Rules of Botanical Nomenclature." There remain, however, certain points which have to be settled by the Nomenclature Section of the London Congress in 1915.

The program of work for 1915 was defined by the Congress of 1910 as follows:

1. To fix the starting-point for the nomenclature of

   (*a*) Schizomycetes (Bacteria);
   (*b*) Schizophyceæ (excepting Nostocaceæ);
   (*c*) Flagellatæ;
   (*d*) Bacillariaceæ (Diatomaceæ).

2. To *compile lists* of nomina generica utique conservanda for

   (*a*) Schizomycetes;
   (*b*) Algæ (incl. Schizophyceæ, Flagellatæ, etc.); new lists for groups not included in the list of 1910 and also a supplementary list;
   (*c*) Fungi;
   (*d*) Lichens;
   (*e*) Bryophyta.

3. Compilation of a double list of nomina gener-

ica utique conservanda for the use of paleobotanists.

4. Discussion of motions relating to new points which were not settled by the rules adopted at Vienna in 1905 and at Brussels in 1910.

The carrying out of this work has been entrusted to two committees under the direction of a rapporteur général, Dr. J. Briquet (Geneva), assisted by a vice-rapporteur, Professor H. Harms (Berlin). In the compilation of the lists of nomina conservanda, the rapporteur général will have the assistance of a certain number of editors in each committee. On these several committees the following names of American botanists are found:

Dr. A. Evans, New Haven, Conn., U. S. A. (Hepatics).

Professor A. J. Grout, 360 Lenox Road, Brooklyn, N. Y., U. S. A. (Mosses).

Dr. J. C. Arthur, Purdue University, Lafayette, Ind., U. S. A. (Fungi).

Professor G. F. Atkinson, Cornell University, Ithaca, N. Y., U. S. A. (Fungi).

Professor W. G. Farlow, Harvard University, Cambridge, Mass., U. S. A. (Fungi).

Dr. R. Thaxter, Harvard University, Cambridge, Mass., U. S. A. (Fungi).

F. S. Collins, 97 Dexter St., Malden, Mass., U. S. A. (Algæ).

Dr. F. H. Knowlton, U. S. National Museum, Washington, D. C., U. S. A. (Paleobotany).

Ch. D. White, U. S. National Museum, Washington, D. C., U. S. A. (Paleobotany).

The circular further explains as follows:

The functions and program of work of these committees are as follows:

1. The Rules of Nomenclature adopted at Vienna in 1905 and at Brussels in 1910 remain in force. Additions may be made to the present code only: (1) in the form of rules bearing on new points not covered by the decisions of 1905 and 1910; (2) in the compilation of supplementary lists of nomina generica utique conservanda, and in fixing the starting-point for the nomenclature of special groups, as stated above.

2. All motions must be presented in the form of additional articles to the rules of 1905–1910, drawn up in French in the form adopted in the International Code now in use. Lists of nomina generica must be drawn up in conformity with the scheme adopted in the "Rules," edition 2.

3. Motions must be drafted as briefly as possible in Latin, French, German, English or Italian. So far as possible, statistics should be supplied, indicating the consequences of the proposed motions.

4. At least sixty printed copies of the motion with the grounds of support must be sent to the rapporteur général before April 30, 1914.

5. Motions will be communicated by the rapporteur général to the members of the committees as they arrive. The members of the committees who were nominated at Brussels in 1910 are regarded as having accepted nomination, unless they have expressly signified the contrary to the rapporteur. Committees may, in case of necessity, co-opt new members who are specially competent.

6. The rapporteur général will draw up, after May 31, 1914, a critical and classified résumé of the motions which have been submitted and of the lists compiled by the special editors. He will submit this résumé to each member of the committees, and will draft on the basis of the collected motions a supplement to the Rules of Nomenclature. The work of the committees and of the rapporteur will be completed by November 30, 1914.

7. This supplement to the "Rules" will be sent out before January 1, 1915, to the principal botanical societies, and to the important botanical institutions in the different countries, and also to the principal periodicals, particularly those which specialize in cryptogamic botany and paleobotany.

8. Motions which reach the rapporteur after April 30, 1914, can be submitted to the Nomenclature Section of the Congress, only on condition that at least one hundred printed copies are sent to the president of the Section before the opening of the discussion, and that a majority of two thirds of those voting is in favor of their acceptance. New motions presented during the discussion can be admitted only if a majority of two thirds of those voting is in favor of their acceptance, and will not be voted upon until the next day.

9. The rapporteur will preserve all the documents which have been used in the elaboration of the proposed supplement to the "Rules of Nomenclature." These documents will be available for the use of the Congressists in London.

10. The revision of the Rules of Nomenclature has already occupied three congresses, namely, at Paris, Vienna and Brussels, and by 1915 the rapporteur général will have followed their details for fifteen years. It is highly desirable from all points of view that this work should be completed in London in 1915, and should cease to occupy the International Botanical Congresses. We, therefore, urgently beg botanists in general, and cryptogamists and paleobotanists in particular, to examine

carefully these points which still require consideration, and to formulate their propositions in such a manner that nothing may be left over for 1920.

11. A later circular will supply detailed information on the internal organization of the Nomenclature Section of the Congress so far as concerns the nomination of delegates, the discussion of motions, and the propositions of the Committees; also on the method of voting.

American botanists should remember the following addresses:

Dr. J. Briquet, Botanical Garden, Geneva, Switzerland—rapporteur général.

Dr. A. B. Rendle, British Museum (Nat. His.), London, Eng.—general secretary.

THE AMERICAN SOCIETY OF NATURALISTS

MEMBERS of the American Society of Naturalists, in common with other scientific societies, have been invited by the organizing committee of the Nineteenth International Congress of Americanists to participate to the fullest extent possible in the important session to be held by the Congress in Washington October 5–10, 1914.

Following the meetings there will be a very instructive trip, including visits to the museums of Philadelphia, New York, Brooklyn and Cambridge, to the museum and mounds at Columbus, Ohio, and to the museums of Chicago and Davenport; and finally there will be an extension of the trip to Denver, Santa Fé, and certain cliff-dwelling as well as other archeological remains of Colorado and New Mexico, terminating with a pre-arranged visit of scientific interest to the living Pueblo Indians.

Requests for further information and applications for membership in the Congress should be addressed to the secretary of the Congress, Dr. A. Hrdlička, United States National Museum, Washington.

BRADLEY M. DAVIS,
Secretary

SCIENTIFIC NOTES AND NEWS

THE present issue of SCIENCE is the thousandth number of the new series.

DR. HERMANN M. BIGGS was the guest of honor at a dinner given by two hundred of his professional colleagues in New York on February 7. Among the speakers were Professor Wiliam H. Welch of Johns Hopkins University, Dr. William H. Park, Mr. Robert W. De Forest and Borough President Marks.

AT the commemoration day exercises of the Johns Hopkins University, a portrait was presented of Dr. Edward H. Griffin, professor of philosophy, to mark the twenty-fifth anniversary of his professorship.

THE Rumford Committee of the American Academy has made the following appropriations: To Alphcus W. Smith, of Ohio State University, $100 for his research on the Hall and Nernst effects in the rare metals; to Charles G. Abbot, of the Smithsonian Institution, $150 for his research on the application of solar heat to domestic purposes.

PROFESSOR WALLACE W. ATWOOD, formerly of the University of Chicago, has taken up his new work at Harvard University. His address will now be Harvard University, care of University Museum, Cambridge, Mass.

PROFESSOR A. N. TALBOT, in charge of theoretical and applied mechanics at the University of Illinois, has been appointed chairman of the joint committee on stresses in railway track and subgrade of the American Society of Civil Engineers and the American Railway Engineering Association.

DR. M. G. DONK, of the bureau of chemistry, has been detailed by the department of agriculture to cooperate with the department of forestry at the University of Idaho in investigations looking to better methods of utilizing mill waste and refining by-products obtained from stumps. The work will be a continuation and extension of experiments which have been carried on for the past three years by Dr. C. H. Shattuck, head of the department of forestry at Moscow.

SIR FRANCIS DARWIN delivered the first Galton anniversary lecture on February 16. The subject of the lecture was Francis Galton.

IN the latter part of January, Dr. Arthur L. Day, director of the geophysical laboratory of

the Carnegie Institution of Washington, gave a course of five lectures before the graduate students of the geological department of the University of Chicago, on the genesis of minerals, eutectics and the volcanic gases of Kilauea. These were followed by a course of six lectures by Dr. John Johnston, of the same institution, on the chemical and physical effects of pressure and their bearing on certain geological problems. Both courses were also attended by the graduate students of allied scientific departments and by members of the staff.

DR. SHOSUKE SATO, of the Imperial University of Sapporo, Japan, will give a series of lectures at the University of Illinois, April 13 to 25. The general subject is "Fifty Years' Progress in Japan."

ON February 11, Mr. E. J. Mehren, editor of *The Engineering Record,* delivered a lecture before the college of engineering of the University of Illinois on "The Making of a Technical Journal." Mr. Mehren graduated from the University of Illinois in Civil Engineering in 1906.

PROFESSOR ARTHUR H. BLANCHARD, of Columbia University, on February 14 delivered illustrated lectures at the University of West Virginia on the subjects: "Park Boulevards," "Bituminous Surfaces and Bituminous Pavements," "Wood Block and Stone Block Pavements" and "Modern Developments in Highway Engineering in Europe."

Two years' salary, amounting to $5,570, was voted by the United States Senate on February 12, to the widow of Dr. Thomas W. McClintock, of the United States Public Health Service, who died from spotted fever contracted while he was making researches into the cause and cure of the disease.

WE learn from *Nature* that it has been decided to prepare for publication a biography of the late Sir William H. White, K.C.B., the eminent naval constructor. Mr. J. B. Capper, to whom the work has been entrusted, will be grateful for any material in the shape either of correspondence or of reminiscence throwing light upon Sir William White's personality or work. Letters will be carefully preserved, copied and returned. Communications of all kinds should be addressed to Mr. Capper, care of Sir Henry Trueman Wood, secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.

DR. ROBERT KENNEDY DUNCAN, director of the Mellon Institute for Industrial Research of the University of Pittsburgh, died on February 18, in his forty-sixth year.

PROFESSOR WILLIAM WHITMAN BAILEY, professor emeritus of botany at Brown University, died at Providence on February 20, aged seventy-one years.

DR. ARTHUR HENRY PIERCE, professor of psychology at Smith College, died at Northampton on February 20, aged forty-four years.

DR. LAZARUS SCHÖNEY, a surgeon and scientific author, died at Coney Island, New York, on February 18, aged seventy-six years.

DR. R. T. ORMOND, known for his work in meteorology, died at Edinburgh on January 27.

THE sixth semi-annual meeting of the American Institute of Chemical Engineers will be held at Troy, N. Y., June 17-20, 1914.

OWING to the agitation to prevent the success of the International Congress of Ophthalmology to be held in St. Petersburg, Russia, on account of the exclusion of some and the restrictions imposed on other Jewish members, the following announcement was made early in January by Professor Bellarminoff, the head of the congress at St. Petersburg: "The minister of the interior has granted, without exception, unhindered entrance into the empire and unlimited stay to all members of the Twelfth International Congress of Ophthalmology."

THE program for the twenty-eighth year of the botanical seminar of the University of Nebraska has been issued, giving the papers which will be presented before some twenty meetings that will be held in the course of the year.

WE learn from the *British Medical Journal*

that the oldest medical school in Australia, that of the University of Melbourne, will celebrate its jubilee this year. Work actually commenced in 1861, but its original buildings were not opened till two years later. The roll of medical graduates already numbers about 1,100, and over 380 medical students are now attending full courses of instruction. The Melbourne School has from the first insisted on a five years' course, and its degrees have been registrable in the United Kingdom since 1890. The celebrations will commence on Thursday, April 30, and will last three days. The university is asking the state government to provide funds for the appointment of assistant professors of anatomy, physiology and pathology, the proper staffing of these departments being regarded by the faculty of medicine as the most pressing want of the school. Old graduates are being invited to contribute varying sums annually for five years to a permanent fund, the interest of which will be devoted to the promotion of clinical research in the teaching hospitals of Melbourne. A history of the medical school is being prepared. The jubilee celebrations will include an inaugural ceremony in the Wilson Hall of the university; a series of short addresses on the history, needs and prospects of the school; demonstrations in the laboratories, museums and hospitals; a jubilee dinner, and a theater party. A portrait of the dean of the faculty, Sir H. B. Allen, is to be painted for presentation to the university.

The conclusions reached as a result of six years' exploration in the Yukon-Tanana region, Alaska, by L. M. Prindle, have been published by the United States Geological Survey in Bulletin 525. It has been found that the placer-gold reserves of the Fairbanks district, even if only those deposits that can be mined by methods now in use are considered, are still very large. There are, however, still larger deposits of auriferous gravels whose content of gold is so small that they can be profitably handled only by improved methods of mining. These facts and the existence within the district of extensive alluvial deposits, which have not been thoroughly prospected, make the outlook for placer mining in the region exceedingly hopeful. It is therefore by no means certain that the placer-mining industry will continue to decline as it has declined in the last two years. A large expansion of the industry in this field can be brought about only by lessening the operating costs through improved means of communication. As compared with alluvial mining, the lode-mining operations have been insignificant and have yielded no great body of facts upon which to base conclusions as to the persistence of the lodes. The facts presented in the report, however, show that the geologic conditions on the whole appear to be favorable to the occurrence of lode deposits and that these are not limited to the localities near Fairbanks which have been prospected.

The International Conference on the Safety of Life at Sea, first suggested by the German emperor and convened by the British government, has now held its final meeting. We learn from *Nature* that as a result of its labors, a very important convention has been signed by plenipotentiaries of the following states: The British Empire, including Australia, Canada and New Zealand, which were represented separately, Germany, France, the United States, Austria-Hungary, Italy, Spain, Sweden, Norway, Holland, Belgium and Denmark. The text of the convention has not yet been published, but the chairman of the conference, Lord Mersey, has outlined its principal points in a speech moving its acceptance by the delegates. The convention must be ratified by the different states prior to December 31, 1914, and comes into force on July 1, 1915. An international service is to be established and placed under the control of the United States for the purpose of ice patrol and observation and for the destruction of derelicts in the North Atlantic. The masters of all vessels are to cooperate with this service. Safety of construction has been dealt with under the headings of "New vessels," and "Existing vessels." The convention provides that the degree of safety shall increase in a regular and continuous manner with the length of the vessel, and that vessels shall be as effi-

ciently subdivided as is possible having regard to the nature of the services for which they are intended. The convention provides that all merchant vessels of the contracting states when engaged upon international (including colonial) voyages, whether steamers or sailing vessels, and whether they carry passengers or not, must be equipped with wireless telegraphy apparatus if they have on board fifty persons or more (except where the number is exceptionally and temporarily increased to fifty or more owing to causes beyond the master's control). There are certain exemptions to this regulation. A continuous watch for wireless telegraphy purposes is to be kept by all vessels required to be fitted with wireless apparatus, as soon as the government of the state to which the vessels belong is satisfied that such watch will be useful for the purpose of saving life at sea. Meanwhile certain classes of vessels are specified as being required to maintain a continuous watch. The wireless installations must have a range of at least 100 miles. A transition period is provided to enable wireless apparatus to be fitted and operators and watchers obtained. The convention lays it down that there must be accommodation in lifeboats or their equivalents for all persons on board, and that as large a number as possible of the boats and rafts must be capable of being launched on either side of the ship, so that as few as possible need be launched on the weatherside. The convention specifies a minimum number of members of the crew competent to handle the boats and rafts. All ships are to have an adequate system of lighting, so that in an emergency the passengers may easily find their way to the exits from the interior of the ship. Ships of the contracting states which comply with the requirements of the convention are to have furnished to them certificates of the fact, which are to be accepted by all the states as having the same value as the certificates issued by them to their own ships.

UNIVERSITY AND EDUCATIONAL NEWS

Lehigh University will receive about $800,000 under an adjudication of the eleventh account of the executors and trustees of the estate of Asa M. Packer.

The Mask and Wig Club of the University of Pennsylvania has completed plans for the erection of a residence, to be presented to the university for the use of the provost. The building will cost between $75,000 and $100,000.

Miss Emily Matilda Easton has by her will made a number of public bequests including £10,000 to the College of Medicine of the University of Durham and £5,000 to Armstrong.

Sir William Macdonald, of Montreal, has been elected chancellor of McGill University, in succession to the late Lord Strathcona.

Dr. Forchheim, professor in the Graz Technological School, has accepted the commission to organize a technical school at Constantinople.

The following appointments for the faculty of George Peabody College for Teachers, the new Teachers College of the South, have been announced: Carter Alexander, Ph.D., professor of school administration (formerly assistant professor of educational administration, University of Missouri); Lula O. Andrews, A.M., assistant professor of English (formerly professor of English language. State Normal School, Farmville, Va.); John Lee Coulter, Ph.D., professor of rural economics (at present with the United States Census Bureau); Kary C. Davis, Ph.D., professor of agriculture (formerly professor of agronomy and principal of agricultural short courses, of the State Agricultural College of New Jersey); Frederic B. Dresslar, Ph.D., professor of school architecture and hygiene (formerly special agent of the United States Bureau of Education); Charles E. Little, Ph.D., professor of the teaching of Latin (formerly professor of Latin in the old Peabody College); Robert W. Selvidge, A.M., professor of manual and industrial arts (formerly professor of manual arts at the University of Missouri); Edward K. Strong, Jr., Ph.D., professor of psychology and psychology of education (now in the department of psychology, Columbia Univer-

sity); William K. Tate, A.M., professor of rural education (now professor of elementary education, University of South Carolina).

DISCUSSION AND CORRESPONDENCE

GRADUATE WORK IN AMERICAN UNIVERSITIES

The university registration statistics published by Professor Tombo in Science, January 23, 1914, allow, among other things, an interesting and instructive comparison of the amount of graduate work being done in the thirty universities tabulated. The number of non-professional graduate students may be taken to represent the amount of research that is being done in a university, for, in general, a university will attract non-professional graduate students in proportion to the activity in the graduate departments. The relative amount of emphasis laid on graduate work in each university can be seen at a glance in the table below, where the thirty universities in question are arranged in rank according to the ratio of non-professional graduates to undergraduates, *i. e.*, the number of graduates to every hundred undergraduates. The first column gives the ratio of graduates to undergraduates based on the figures given under "College, Men," "College, Women" and "Non-professional Graduate Schools" in Professor Tombo's table.[1] The second column gives the total enrollment listed under these three heads, corresponding presumably with the enrollment of purely academic students.

University	Ratio	Total Students
1. Johns Hopkins	123	397
2. Pennsylvania	107	1,504
3. Columbia	102	2,960
4. New York	52	1,076
5. Illinois	32	1,097
6. Chicago	28	2,183
7. Cornell	28	1,435
8. Cincinnati	27	789
9. Yale	24	1,736
10. Wisconsin	18	1,894
11. Harvard	17	3,403
12. California	15	3,146
13. Washington	15	438
14. Princeton	14	1,443
15. Ohio State	13	1,018
16. Nebraska	13	1,443
17. Pittsburgh	12	438
18. Iowa	11	1,293
19. Virginia	11	439
20. Michigan	9	2,745
21. Missouri	9	1,473
22. Minnesota	8	1,648
23. Stanford	8	1,877
24. Tulane	8	345
25. Northwestern	8	1,173
26. Indiana	7	1,200
27. Kansas	6	1,729
28. Syracuse	6	1,415
29. Texas	5	1,597
30. Western Reserve	1	826

[1] Science, p. 126.

The ranking of the universities obviously does not correspond in every case with the amount of productive scholarship that is issuing from a university, but, as far as the enrollment figures are correct, it would seem to indicate the relative emphasis that is being put upon graduate work. A correlation of the totals as given in the second column with the ratios of the first column gives a coefficient of about .046, or practically no correlation at all. This might be interpreted to mean that the universities possessing enormous undergraduate departments do not as a rule show an increased activity in graduate work, such as the number of undergraduates should warrant, presuming, of course, that the ultimate ideal of a university is held to be productive scholarship.

Rudolf Pintner

Ohio State University

THE CAUSE OF THE PECULIAR SOUND MADE BY NIGHTHAWKS WHEN VOLPLANING

All are familiar with the resonant sound made by the nighthawk as he cavorts through the air. It may be described as a guttural "woof."

It has been a contested point as to whether this sound was produced by the open mouth or the wings. As it occurs at the point where the bird swerves upward in his downward glide and at no other time, it is very evident that the mouth plays no part, otherwise the sound would occur at other times.

While on Mt. Constitution, Orcas Island, Washington, about five o'clock in the evening one summer, Mark Said and I were watching the nighthawks in their tortuous flight. Unexpectedly one of the nighthawks made its dip, with the accompanying "woof," but a few feet from Mr. Said.

According to his description the bird threw its wings far to the front at the end of his downward glide, so that the uppermost quill feathers were pointed exactly in the direction of his glide. Going at such headlong speed, these quill feathers when thrown edgewise to the air vibrated strongly, causing the "woof."

Frank A. Hartman

Seattle, Wash.

SCIENTIFIC BOOKS

Vorlesungen über Landwirthschaftliche Bakteriologie. By Dr. F. Löhnis, Professor an der Universität Leipzig. Berlin, Verlag von Gebrüder Borntraeger, W. 35 Schöneberger Ufer 12a. 1913.

Agricultural bacteriology is gaining prominence in scientific and practical circles. The agriculturist realizes more and more that scientific investigations are of help to him and the demand on colleges for courses in agricultural topics is constantly increasing. However, text-books are still scarce. The series of lectures by Professor Löhnis is the outcome of a course of lectures in connection with a general course in agricultural bacteriology given by him in the University of Leipzig.

The ground is covered as thoroughly as modern knowledge permits. No one realizes more fully than the author how much work is needed to complete our really very meager knowledge in many agricultural branches. The reader must be impressed with the fact, frequently stated, that research is necessary and that authors do not agree in many instances.

The book is divided into two parts—a general part and a special part. The general part consists of fourteen lectures. The first lecture gives a general introduction to the significance and the problems of agricultural bacteriology and includes a historical review and a list of some important books bearing on the subject. The shape, development and classification of microorganisms is covered in two lectures. The size of bacteria is admirably illustrated by diagrams showing the relation of the bacterial content of milk, butter and cheese to definite quantities of these substances. Such illustrations render the book exceptionally valuable, especially to students. Three lectures are devoted to conditions of existence and multiplication of microorganisms and two lectures to methods of cultivation and combating microorganisms.

Under the general head of "Products of Microorganisms" six lectures are united. The production of pigment, light and heat are discussed. The circulation of nitrogen, carbon, hydrogen and oxygen are given with considerable detail and illustrated in diagrammatic fashion. These complicated subjects are dealt with in masterly fashion, notwithstanding the fact that some facts are still poorly understood. Similarly, a lecture is given to the discussion of the decomposition and assimilation by bacteria of phosphorus compounds and the solution of carbonates and silicates. Mention is also made in this lecture of sulphur and iron bacteria. For the sake of completeness one lecture deals with pathogenic functions of microorganisms. It is hardly necessary to state that this extensive subject is treated briefly. However, the chief principles of virulence, infection, immunity, vaccination, serum therapy and chemo-therapy are ably dealt with.

The second "special" part commences with a lecture on the bacteriology of foods for cattle. Here the author forcefully shows the rôle played by microorganisms in the ripening and decomposing of foods. Many gaps in our knowledge are clearly pointed out.

Two interesting lectures give the student the most necessary knowledge of the milk question. The attitude of the author in regard to this important subject is of special interest. There are at present in this field the extreme views of those commercially interested and the no less extreme views of some sanitarians. Professor Löhnis takes an intermediate position, recognizing the necessity of

gradual, rather than forced, improvement in the milk supply, and sanitarians are warned against entertaining premature conclusions. Those sanitarians who have recklessly connected mastitis in cows with human diseases receive criticism from the author, although he does not neglect to emphasize that milk from cows with diseased udders should be rigorously excluded from human consumption, unless previously boiled. The author also points out that—as desirable as it is to establish grades of market milk—existing regulations are rarely reasonable and generally immature. Numbers of bacteria in milk are of relatively smaller significance than the possible presence of pathogenic bacteria. These may multiply in milk of small bacterial content more rapidly than in milk rich in bacterial life. Special emphasis is laid on the necessity of instructing producers. And here it must be stated that Professor Löhnis ranks among those old-world scientists who are ready to give full credit to American workers in agricultural fields.

One lecture is devoted to the bacteriology of butter and two lectures to cheese. There are five lectures on the bacteriology of manure and soil. These are also conservative and critical. Finally, the whole subject is reviewed in a retrospect and a prospect. Valuable suggestions for those interested in research work in agricultural lines are given.

As a whole the subject-matter is presented in good style, the numerous illustrations are exceptionally clear, and no one can read the book without adding materially to his knowledge and broadening his views.

P. G. Heinemann

Franz von Kobells Lehrbuch der Mineralogie. Seventh edition. By K. Oebbeke and E. Weinschenk. Leipzig, Friedrich Brandstetter. 1913. Pp. viii + 405; 1 plate; 344 figures in text. Price, 8.50 Marks.

In 1899 the sixth edition of this popular German text-book on mineralogy appeared under the same joint authorship as the present edition. In the new edition the text has been increased by 67 pages. The general portion has been entirely rewritten and the descriptive part revised so as to bring the mineral data up to date.

There are three subdivisions in the general part, namely: (1) Crystallography, (2) Physical Mineralogy, and (3) Chemical Mineralogy; the special part is devoted to Descriptive Mineralogy.

Crystallography is discussed in 70 pages and under three headings, (*a*) general morphological properties of minerals, (*b*) special geometrical properties of crystals and (*c*) twins, development and intergrowths of minerals and inclusions. The discussion of crystallography is well adapted to the needs of the beginning student. The more important classes of crystals are considered at length upon the modern basis of symmetry, but reference is also made to the rather useful ideas from the standpoint of pedagogy of holohedrism, hemihedrism and so forth. The crystal drawings are exceptionally clear. Fig. 51 is, however, inverted.

Thirty-seven pages are devoted to physical mineralogy, which includes the following subdivisions, (*a*) specific gravity, (*b*) elasticity and cohesion, (*c*) optical properties and (*d*) miscellaneous physical properties. The discussions in this section are again limited to only that which is of importance to the student who has a general knowledge of mineralogy in mind. Thus, the polarization phenomena of crystals are disposed of in 14 pages.

The next 60 pages are devoted to chemical mineralogy. Here, (*a*) general chemical properties, (*b*) occurrence and formation, (*c*) weathering and decomposition, (*d*) synthesis and (*e*) classification and nomenclature of minerals are discussed. The chapter on the occurrence and formation of minerals contains a large amount of information not usually included in text-books on mineralogy of this character. Brief reference is first made to the classification, form, structure and paragenesis of mineral deposits. Then follow concise descriptions of the various types of the more important rocks and mineral deposits. This chapter is very well written, and similar discussions could be introduced to advantage in American texts on mineralogy.

In the descriptive portion, extending over 215 pages, the classification of minerals according to elements is followed. The mineral descriptions are generally adequate, although native copper is disposed of in about one half page and with but four lines devoted to the Lake Superior occurrence. The statistics relating to the production of minerals are for 1910.

This edition of von Kobell's mineralogy of only 405 pages is much more comprehensive than any other text on the subject of similar compass. The authors are to be congratulated upon the clear and concise manner in which this wealth of material has been presented.

Edward H. Kraus

Mineralogical Laboratory,
University of Michigan

Outlines of Theoretical Chemistry. By Frederick H. Getman, Ph.D. John Wiley & Sons. 1913. Pp. ix + 467.

This book is written primarily for the use of students beginning the study of physical chemistry. It is always interesting to have the viewpoint of a new author in such an extended field as modern physical chemistry. The array of facts and theories in the recent literature of physical chemistry is so vast that necessarily each teacher must be content to select what he considers to be the most important principles and of need neglect others. Dr. Getman has chosen to chapter and classify nineteen lines of discussion. After discussing briefly the atomic theory and the periodic law, the conventional fields of physical chemistry are developed historically in most cases. This historical treatment is carefully handled for the most part, the tendency being throughout the book to treat the subjects considered from the viewpoint of the original investigators. While this treatment is excellent in most cases, a little more personality injected would clear certain points. For example, the chapter on Electrons can not give the student anything more than a very vague idea of the subject. On the other hand, the subjects of Thermochemistry, Equilibrium, Electromotive Force and Actinochemistry are very clearly and satisfactorily handled.

The addition of a series of well-selected problems at the end of each chapter is to be highly commended.

While the press work of the book is of the same high quality as that of Wiley & Sons' text-books, it is to be regretted that the cost to the student is as much as $3.50.

Victor Lenher

BOTANICAL NOTES

SMALL'S MANUALS

Dr. J. K. Small, of the New York Botanical Garden, has been very industrious in the preparation of systematic manuals of botany as shown by his "Flora of the Southeastern United States," now in its second edition, his "Flora of Miami," "Florida Trees," both of which appeared during 1913, and now we have a "Flora of Lancaster County" (Penn.) in collaboration with the late J. E. Carter. The first-named books were noticed in these columns when they appeared, and it remains only to notice the last. While the Florida manuals dealt with a *terra incognita*, the Flora of Lancaster County deals with a region which "has been the scene of almost continuous botanical exploration and study for nearly a century and a half." In fact the work was begun by Muhlenberg in the latter part of the eighteenth century. Somewhat more than forty years ago Professor T. C. Porter published an enumeration of the indigenous and naturalized plants of the county, and this has formed "the basis of the present flora."

The book includes about 350 pages, and is an actual descriptive manual, and not a series of keys. In other words the treatment here reminds one of that in such a manual as Britton's, or Gray's, and while keys are freely used, the genera and the species are separately described. One wishes that more local floras could be modeled after this very satisfactory little book.

BOTANICAL NOTES

From the Central Experimental Farm at Ottawa, Canada, there comes a bulletin (No. 73) of more than ordinary scientific interest.

It is entitled "Smut Diseases of Cultivated Plants, Their Cause and Control," and was prepared by the Dominion Botanist, Mr. H. T. Güssow. In somewhat less than sixty pages the author presents in fairly non-technical language the important facts about smut fungi in general, followed by details regarding ten species which attack wheat, barley, oats, corn, broom corn, and millet. In an appendix the latter are described botanically for the benefit of students. Good figures, which are freely used, help both the farmer and the student to identify the diseased hosts, as well as the parasitic fungi. Preventive and remedial measures are suggested at every step. The importance of such a bulletin may be appreciated when we remember that it is estimated that Canadian farmers annually lose about $15,000,000 from the ravages of these smuts.

Botanists and foresters will be glad to know that Professor A. F. Blakeslee and his colleague, C. D. Jarvis, have reprinted the Keys to the Genera and Species of Trees in the Eastern United States. These were originally in their book "Trees in Winter," and the many requests from teachers and others for separate copies of these keys have induced the authors to issue them in a 15-page pamphlet. It may be obtained of the authors at Storrs, Conn., for 30 cents, and should prove helpful to teachers who are trying to teach their pupils how to know the names of the trees about them.

Some months ago there came to hand the Annual Report of the Agrostologist and Botanist of the Transvaal for the year 1911, bearing date of June, 1912, but issued later from the press. It was prepared by Professor J. Burtt-Davy, the well-known botanist of south Africa, and contains many items of considerable botanical interest, especially to those whose interest extends to applied botany. A large part of the paper is devoted to a discussion of the plants suspected of being poisonous to cattle ("lamziekte").

Among recent contributions from the United States National Herbarium (Volumes 16 and 17) are the following: Cook and Doyle's Stilt Palms (*Iriartineae*), describing three new genera; Britton and Rose's Studies in Cactaceae, in which they describe seven new species from Mexico, Guatemala and Panama; Cook's Relationship of *Pseudophoenix*, a curious relative of the Date Palm; Britton and Rose's Genus *Epiphyllum*, in which two new genera and five new species are described from Mexico and southward: Smith and Rose's Monograph of certain tribes (Hauyeae and Gongylocarpeae) of the Onagraceae, represented by Mexican and Californian genera; Maxon's Fourth instalment of his Studies of Tropical American Ferns, containing notes on *Asplenium trichomanes*, *Dicksonia*, *Odontosoria*, and other fern genera, and new species of *Lycopodium;* Hitchcock's Mexican Grasses in the U. S. National Herbarium, including 133 genera and 613 species. The large genera are *Muhlenbergia* (58 species), *Panicum* (54 sp.), *Paspalum* (39 sp.), *Andropogon* (28 sp.), *Bouteloua* (28 sp.), *Sporobolus* (21 sp.), *Eragrostis* (21 sp.), *Aristida* (19 sp.) and *Stipa* (16 sp.). Six bamboos are enumerated.

The Contributions from the Gray Herbarium of Harvard University (N. S., XLII.) include critical studies of certain genera of Composites, and a report upon the grasses collected in British Honduras by Professor M. E. Peck.

Charles E. Bessey
University of Nebraska

SPECIAL ARTICLES

MITOCHONDRIA IN TISSUE CULTURE

The immense literature[1] which has grown up in the last few years, concerning these minute bodies found in the cytoplasm of various cells in many different species not only of vertebrate and invertebrate animals but also of plants, and the great importance which has been assigned to them by various authors must necessarily arouse even more general interest and increased observation and discussion.

A multiplicity of names has already been given these bodies: mitochondria and chon-

[1] J. Duesberg, *Ergebnisse der Anatomie und Entwickelungsgeschichte*, Bd. XX., 1911.

driomiten by Benda; chondrioconten, chondriosomen, chondrion and plastosomen by Meves; plasmafaden, plasmaköner by Retzius; paramiton or miton by Flemming; microsomen by Van Beneden; granule and filament by Altmann.

The mitochondrial theory has been most widely promulgated by Benda (1899–1903) and Meves (1907–1908). Duesberg states the theory concisely as follows: the mitochondria are specific elements of the cytoplasm, which arise from preformed elements in the male and female sex cells and are carried over into every cell at mitosis. These bodies differentiate into specific parts of the various adult tissues. While there are many authors whose observations tend to substantiate the mitochondrial theory, on the other hand just as many writers refuse to accept the mitochondrial theory in its entirety. Some give observations to show that the mitochondria are formed from nuclear material at certain periods of the cell's activity.[2] Others claim that they are fermentation products of the activity of the centriole,[3] and still others state that the mitochondria are throughout entirely different elements whose identity have nothing in common.[4]

The tissues from chick embryos grown outside the body in media of known chemical constitution, which we have been studying during the past three years, with other problems in mind, have shown such beautiful mitochondria in both fixed and living specimens that we are led to believe this method offers a better opportunity for their study than any heretofore used.

Small pieces of tissue from a chick embryo, four to ten days old, suspended in a drop of Lock's solution containing 0.25 per cent. dextrose are placed on the sterile surface of a clean coverslip. The coverslip is then inverted over a hollow ground slide, sealed with vaseline, and incubated at 39° C.; growth usually appears at the end of 10–20 hours. Such preparations are studied on the warm stage with the No. 2 Zeiss apochromatic and a No. 4, 6 or 8 ocular.

Janus green in strengths of .00001 and .000005 of 1 per cent. stains the mitochondria in the living cells a brilliant blue green. The color fades, however, in from 15 minutes to 3 hours, and we have been unable to restain. The janus green is also slightly toxic and kills the cells in a few hours. We are indebted to Dr. E. V. Cowdry for this particular janus green (di ethyl saffranin azo di methyl aniline) which was obtained by him from Dr. Bensley of Chicago. Attempts to stain with another make were unsuccessful.

Nilblew B. extra, for which we are indebted to Dr. Herbert Evans, was used in very dilute solution of .000005 to .0000025 of 1 per cent. for the detection of lipoids in connection with the mitochondria. It stains the lipoids pink, but is unfortunately somewhat toxic and, like the janus green, kills the cells in a few hours.

The preparations are fixed by placing the coverslip in a chamber of osmic acid vapor from two to five minutes and since the growth is very thin, the fixation is almost instantaneous and the mitochondria remains practically the same as in the living cells. The blackening caused by the osmic is bleached during the hardening processes by means of a few drops of hydrogen peroxide in the 70 per cent. alcohol and the preparations are then stained with Heidenhain's iron hematoxylin. Since in places the cells are flattened out on the under surface of the coverslip into a single layer much thinner than the usual thickness of a single cell, one can study the entire living cell and its contents with a minimal amount of focusing. Also at any moment during the observations the culture can be fixed and later the same cells studied in a stained preparation.

Mitochondria were studied in endothelium, mesenchyme, giant cells, ectoderm, heart muscle, smooth muscle and endoderm.

The stained preparations show great variety in the shape of mitochondria and often in the same specimen, as of heart muscle or mesenchyme, all the so-called types described by

[2] R. Hertwig and Goldsmith, 1909.

[3] Vejdovsky, 1907.

[4] Veratti, 1909; Pensa, 1911; Linidegard, 1910; Gurwitsch, 1910.

other observers are to be found. In such specimens, granules, rods, threads, loops and networks can be arranged in a continuous series; in other words, there are to be found in single stained preparations all gradations of size and shape from the small and large granules to short rods and long rods, to threads of varying length, to anastomosing threads and networks, which extend throughout the cytoplasm and to rings and loops of various shapes.

Certain kinds of cells do, however, contain characteristically shaped mitochondria. Intestinal or stomach endoderm shows only granules and short rods. Heart and smooth muscle cells contain in addition to the usual types large round and spindle-shaped mitochondria. In the heart muscle cell the appearance of the central body, probably the centrosome, at the base of the nucleus, is much more definite than in most cells. The mitochondria radiate out from this central body as though under the influence of the activity of the centrosome, as is believed by Vejdovsky.

By far the most important and interesting are the observations on the living cells. In the living cells the mitochondria are seen as slightly refractive opaque bodies. They can be studied from minute to minute over a period of several days if necessary. The mitochondria are almost never at rest, but are continually changing their position and also their shape. The changes in shape are truly remarkable not only in the great variety of forms, but also in the rapidity with which they change from one form to another. A single mitochondrium may bend back and forth with a somewhat undulatory movement or thicken at one end and thin out at the other with an appearance almost like that of pulsation, repeating this process many times. Again, a single mitochondrium sometimes twists and turns rapidly as though attached at one end, like the lashing of a flagellum, then suddenly moves off to another position in the cytoplasm as though some tension had been released. Corresponding to the forms observed in the stained preparations we find in the living that granules can be seen to fuse together into rods or chains, and these to elongate into threads, which in turn anastomose with each other and may unite into a complicated network, which in turn may again break down into threads, rods, loops and rings.

The mitochondria in a cell of a living preparation of a piece of heart of a five-day chick embryo studied on the third day after the culture was made presented a very remarkable picture. Radiating out from the central body at the base of the nucleus were numerous granules, rods and thread-like mitochondria. They were seen to elongate to many times their original length, spreading out through the cytoplasm and to anastomose into a complicated network. About fifteen minutes later this network broke up and contracted into threads, rings, loops and rods and granules. This entire process took place without any noticeable change in the position or size of the cell.

The presence of fat is shown by the Nilblew vital stain within the varicose mitochondria. We have not observed any connection between the disappearance of mitochondria and the formation of fat within the cell as stated by Dubreuil.

The question as to whether the mitochondria divide, so that one half of each mitochondrium passes into each daughter cell at mitosis (Benda), is one of the most interesting in the whole field of work upon mitochondria. As yet we are unable to state definitely that such a division takes place. In the cells of the tissue cultures the behavior of the mitochondria is difficult to follow during mitosis, since the body of the cell contracts to much less than the normal size and its processes become exceedingly long and delicate. All of the mitochondria are drawn into the body of the cell and become very short dumb-bell-shaped granules during the late metaphase and anaphase. Owing to the very flat shape of the cells (growing along the coverslip) the spindle always appears horizontal to the coverslip and the plane of cleavage perpendicular to the surface. In some cells during the anaphase the mitochondria were observed to collect in a zone through which the cleavage plane will

later pass, and about equal parts of the mass of mitochondria were included in each daughter cell. In other cells no such definite behavior of the mitochondria takes place. They remain scattered throughout the cytoplasm or are collected at the two poles of the cell during the formation of the daughter cells.

The question of the behavior of the mitochondria during the life history of the cell is one of great interest and we feel confident that this method of study of the living cell will be of great value not only for making observations upon the mitochondria, but also for the study of other activities of the cell.

Can we infer from these observations anything concerning the real nature of the mitochondria? Are they organs of the cell, functioning in a definite manner, in other words a living part of a living cell? If they are organs of the cell, are they concerned in the routine metabolism which takes place in all living cells or are they concerned with the process of differentiation of such structures as the myofibrillæ, neuro-fibrillæ, white fibrous tissue, etc.? On the other hand, are we dealing with inactive metabolic products of the cell, inactive in the sense of not being a part of the living protoplasm? If so, are they excretory products which later are extruded from the cell or storage products which are being continually formed by the activity of the cell and again used up in its metabolism? What relation do they bear to the metabolism of the nucleus, if any? The discussion of these most important points must be left for a more complete account of the mitochondria in tissue cultures which is soon to follow.

M. R. Lewis,
W. H. Lewis
Johns Hopkins University

ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The sixteenth meeting of the Astronomical and Astrophysical Society of America was held in Atlanta, Ga., in connection with the American Association for the Advancement of Science on December 29, 1913, to January 1, 1914. The general social features of this meeting participated in alike by the association and the affiliated societies have already been described by the general secretary of the association.

In connection with the relation of this society to the association one matter may be mentioned. Following the adoption of the plan for large general quadrennial meetings the society voted to endeavor to meet with the association for these meetings.

The council elected the following persons to membership: The Rev. T. H. E. C. Espin, Tow Law, Co. Durham, England; Dr. C. C. Kiess, Laws Observatory, Columbia, Mo.; and to honorary membership, Professor G. F. J. Arthur Auwers, Bellevuestr. 55, Grosslichterfelde, Berlin, W., Germany.

The following members were in attendance: G. C. Comstock, W. S. Eichelberger, Philip Fox, C. H. Gingrich, C. S. Howe, W. J. Humphreys, F. R. Moulton, E. C. Pickering, W. F. Rigge, H. N. Russel, Frederick Slocum; and the following visitors from the association: William Bowie, S. M. Barton, E. B. Van Vleck, C. F. Emerson, and R. P. Stephens.

At the joint meeting with Section A of the association two admirable nddresses were delivered. The retiring vice-president of the section, Professor E. B. Van Vleck, presented "The Influence of Fourier's Series upon the Development of Mathematics." The society was represented by Professor H. N. Russell, who spoke on "Relations between the Spectra and Other Characteristics of the Stars."

Aside from these two addresses the scientific program contained twenty-nine papers and a report from the committee on photographic astrometry. The titles are given below in the order of presentation.

"The Arlington Time Signals in Omaha," by W. F. Rigge.

"Astronomical Panoramic Views from a City Observatory," by W. F. Rigge.

"Micrometric Observations of the Holden and Küstner Double Stars," by Philip Fox.

"Note on the Present Spectra of Three of the Novæ," by W. S. Adams and F. G. Pease.

"Note on the Relative Intensity at Different Wave-lengths of the Spectra of Stars having Large and Small Proper Motions," by W. S. Adams.

"Memoir on the Theory of Orbits," by F. R. Moulton.

"Faint Standards of Photographic Magnitude for Selected Areas," by F. H. Seares.

"Temperature, Rainfall and Sunspot Records," by W. J. Humphreys.

"An Easy Method of Drawing the Normals to a Parabola from any Point," by S. G. Barton.

"A Graphical Solution of Cubic Equations," by S. G. Barton.

"The Color of Faint Stars," by F. H. Seares.

"The Moon's Mean Longitude, 1908 to 1913," by F. E. Ross.

"Proper Motion of Telescopic Stars," by G. C. Comstock.

"Errors in the Right Ascensions of Newcomb's Fundamental Catalogue," by W. S. Eichelberger and H. R. Morgan.

"Stellar Parallaxes with the 40-inch Refractor," by F. Slocum and S. A. Mitchell.

"The Objective of the Sproul Telescope," by J. A. Miller and R. W. Marriott.

"Wendell's Photometric Measurements," by E. C. Pickering.

"On the Cepheid Type of Variation," by H. N. Russell.

"Oscillations in the Periods of Cluster Variables and the Coincidence of Visual and Photographic Maxima," by Harlow Shapley.

"The Discovery of Three Naked-eye Variable Stars," by Harlow Shapley.

"Note on the Use of Diffraction Effects in Stellar Parallax Work," by Frederick Slocum.

"Observations of Nebulæ with an Objective-prism Camera," by E. B. Frost and H. L. Alden.

"The Location of the Sun's Reversing Layer," by S. A. Mitchell.

"Spectroscopic Notes from the Detroit Observatory," by R. H. Curtiss.

"Spectrographic Observations of the Nebulæ," by V. M. Slipher.

"The Transmission of Terrestrial Radiation by the Earth's Atmosphere in Summer and Winter," by F. W. Very.

"Note on the Spectrum and Radial Velocity of Ψ Persei," by Paul Merrill.

"The General Magnetic Field of the Sun," by G. E. Hale, F. Ellerman, and A. van Maanen.

"Color Equations of Photographs taken with the 16-inch Metcalf Telescope," by Henrietta S. Leavitt.

"Report of the Committee on Photographic Astrometry: I. Experiments with Wide-angle Cameras; II. Experiments with a Stationary Telescope," by Frank Schlesinger, Chairman.

The next meeting of the society will be held at Northwestern University in August of 1914.

PHILIP FOX,
Secretary

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

At the meeting of the Academy on January 5, Dr. Victor E. Emmel, of the Washington University Medical School, read a paper on "The Problem of the Origin of the Non-nucleated Red Blood Corpuscles."

Dr. Emmel stated that the various views which have arisen in the history of the problem may be briefly stated as including that of intra-cellular nuclear disintegration, nuclear persistence, the hematoblast theory, intra-cellular formation, and the nuclear extrusion theory. With the exception of the hematoblast theory, all of these views are still being seriously discussed, although at the present time that of nuclear extrusion has the greater number of adherents. In contrast to these theories the following results of a study of blood cultures and fresh and fixed blood of the pig embryo appear to support another possible mode of origin for the non-nucleated red blood corpuscles.

It was found that the erythroblast of the pig embryo in place of being spherical, as generally described, may in the later stages of cytomorphosis, assume a biconcave or cup shape; its nucleus becomes smaller, more compact, eccentric in position, and not infrequently flattened in form; mechanically rotated, the erythroblasts tend to orient themselves with the nuclear region remaining on the under side, as if loaded; and that their reaction to changes in osmotic conditions indicates a structural difference between the nuclear and cytoplasmic poles. These observations were discussed with reference to the question of the correlation of the form of the definite plastid with the enucleation of the erythroblast, and formation of a lecithin containing membrane, hemoglobin, differentiation, and the factors involved in determining the eccentric position of the nucleus.

In some eighty culture experiments non-nucleated erythrocytes or plastids were observed to arise from the parent erythroblast by a process of cytoplasmic constriction. In size, form, hemoglobin content and stain these culture plastids are comparable to the normal circulatory plastids. Observations on living and fixed material indicate the occurrence of a similar process within the embryo. These results accordingly raise the question whether the origin of non-nucleated red blood corpuscles by a process of cytoplasmic constriction rather than by nuclear extrusion or intracellular nuclear disintegration does not merit more serious consideration.

G. O. JAMES,
Corresponding Secretary

SCIENCE

Friday, March 6, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE SOLAR CONSTANT OF RADIATION[1]

We live in a world warmed by the sun. While it is not to be expected that everybody will devote himself to the measurement of solar radiation, yet it is not surprising that many have concerned themselves with measuring the quantity on which all lives depend. So far as I am aware, this subject was not pursued by the ancients to such a point as to obtain measurements worth much present consideration. This is a great pity, for thus we lack proof whether the sun's radiation has changed progressively. Beginning about a century ago investigations of solar radiation were pursued with great assiduity by various observers. The need was almost immediately perceived of reducing the observations to represent conditions outside the earth's atmosphere, as, for example, on the moon, so as to be independent of the haze and water vapor and even of the gaseous constituents of the air. It is required to know the measure of solar radiation in free space as an index of the condition of the sun, quite apart from its influence on terrestrial affairs, but secondly it is of great importance and interest to apply this knowledge to promote meteorological inquiries.

Sir John Herschel, who was a pioneer in solar radiation work, proposed to express solar radiation in terms of a unit which he called the actine, which is based on the melting of ice. But by general consent the gram calorie has been adopted as the unit of measurement, and we say that the

[1] Address delivered before the Philosophical Society of Washington, January 3, 1914, as retiring president.

"solar constant of radiation" is the number of calories per square centimeter per minute which would be produced by the complete absorption of the solar radiation in free space at the earth's mean solar distance.

Preparatory researches of great interest were made in the eighteenth century by Bouguer, Lambert, DeSaussure and Leslie. Determinations of the solar constant of radiation, however, may be said to have begun about eighty years ago with the investigations of Sir John Herschel, Principal Forbes and Pouillet. The problem comprises two parts: first, to measure the intensity of the solar radiation at the earth's surface; second, to estimate the loss it has suffered in passing through the atmosphere. It will be convenient to consider the atmospheric influence briefly before taking up the methods of measuring the solar radiation, and then to return to a more thorough discussion of the atmospheric transmission.

ATMOSPHERIC TRANSMISSION

The determination of the transmission of the atmosphere rests primarily upon the hypothesis of Bouguer, first put forward in the year 1729 and elaborated in Bouguer's posthumous work published in the year 1760. The late Dr. Langley has placed this matter in so very clear a light in his paper on the "Amount of the Atmospheric Absorption"[2] that I can not do better than to quote from his statement.

> If a beam of sunlight enters through a crevice in a dark room the light is partly interrupted by the particles of dust or mist in the air, the apartment is visibly illuminated by the light laterally reflected or diffused from them, and the direct beam, having lost something by this process, is not so bright after it has crossed the room, as before. In common language, the direct light, to an observer in the path of the beam, has been partly "absorbed," and the problem is, to determine in what degree. If a certain portion of the light (suppose one fifth) were thus scattered, the beam after it crossed the room would be but four-fifths as bright as when it entered it; and, if we were to trace the now diminished beam through a second apartment altogether like the other, it seems at first reasonable to suppose that the same proportion (*i. e.*, four fifths of the remainder) would be transmitted there also, and that the light would be the same kind of light as before, and only diminished in amount (in the proportion $4/5 \times 4/5$). The assumption originally made by Bouguer and followed by Herschel and Pouillet, was that it was in this manner that our solar heat was absorbed by our atmosphere, and that by assuming such a simple progression the original heat could be calculated.

If A_0 be the intensity of the original beam before entering the transparent medium whose transmission is to be investigated, then after the passage through the first stratum of unit thickness let us suppose a fraction of the original represented by p has passed through, so that what was A_0 becomes A_0p. Then since a second stratum identical with the first in constitution and thickness must, according to Bouguer's assumption, have an identical effect, the ray which was A_0 will emerge from the second stratum A_0p^2, and so on. The fraction p transmitted by the unit of thickness is the common ratio of a geometric progression, so that after passing through a thickness m of the medium, the intensity of the light which was formerly A_0 will become A_0p^m.

As the height to which the atmosphere extends in appreciable density is very small compared with the radius of the earth, the thickness of the layer traversed by a solar beam of a zenith distance not exceeding 70° is approximately proportional to the secant of the zenith distance of the sun at the time of observation. If we regard unit thickness as that corresponding to barometric pressure of 760

[2] *American Journal of Science*, Third Series, Vol. 28, September, 1884.

millimeters of mercury, then p in our formula corresponds to the vertical transmission coefficient of the atmosphere above sea level, and for any station where the barometric pressure is B the intensity of the ray from the sun as it reaches the earth's surface, which we call A, may be expressed by the formula

$$A = A_0 p^{(B/760)\sec z}.$$

Some writers have preferred to use the formula as a formula of "absorption" rather than of transmission. In that way the expression reduces to a somewhat different form, but its fundamental principles are the same. The investigations of Herschel, Forbes, Pouillet and others up to the time of Langley had reference to this exponential formula based upon the hypothesis of Bouguer, which was to the effect that successive equal layers of transparent material transmit equal fractions of the incident ray.

A convenient method of applying the atmospheric transmission formula is to take logarithms of both members of the equation so as to reduce the expression to the form of the equation of a straight line. Thus

$$\log A = \frac{B}{760} \sec z \log p + \log A_0.$$

By this equation the intersept of the best straight line on the axis of ordinates is the logarithm of the intensity of solar radiation outside the atmosphere, and the inclination of the line to the horizontal is the logarithm of the atmospheric transmission for vertical rays.

The reader must bear in mind that the simple expression thus far obtained is given only in illustration of the work of the earlier investigators, and it must be hedged about with certain conditions and limitations in order to apply it, as we shall see later, to the determination of the solar constant of radiation by the most approved methods.

INSTRUMENTS

Herschel's Actinometer.—This instrument consists of a thermometer with a large cylindric bulb, containing a deep blue fluid (the ammoniacal sulphate of copper) and enclosed in a wooden case blackened interiorly and covered with a piece of thick plate glass. The thermometer has a very large bulb, and it is adjusted in volume by means of a screw, so as to regulate the position of the column of liquid on the thermometer scale. Herschel introduced what is termed the dynamical method of observing the solar radiation, for he obtained not the total rise of temperature of the instrument when long exposed to the sun, but its initial rate of rise, corrected for the cooling or warming of the thermometer due to external conditions when the sun is shaded. The determination of the cooling correction is done by observing the rise or fall of the temperature for a certain time interval before exposing to the sun, and again determining the rise or fall after such exposure to the sun is completed. The mean rate of warming or cooling, due to the surroundings, is applied as a correction to the rate of warming due to the exposure to the solar radiation.

Pouillet's Pyrheliometer.—A flat metal box, blackened on the front, and filled with water, had a thermometer inserted at the rear, extending away from the direction of the sun. The instrument, like that of Herschel, was exposed to the influence of the surroundings while shaded for a certain interval of time the shade was then removed for a similar interval so as to allow the solar radiation to fall upon the blackened box, after which the instrument was again shaded. In practise it was found that the water within the box could not be well enough stirred in order to allow the average

temperature of the water to be well ascertained. The instrument was greatly improved by Tyndall, who substituted mercury for water, and, in order to contain the mercury, used iron in the making of the box.

Crova Alcohol Actinometer.—A large spherical bulb thermometer containing alcohol is enclosed in a nickel-plated metal chamber with a vestibule for the entrance of the rays. The stem of the thermometer runs back, directly away from the sun, and is enclosed in a nickel-plated tube with a side opening for reading the thermometer. A short mercury thread is introduced in the alcohol column at a suitable point for observing. The method of observing is the same as that adopted by Herschel and by Pouillet.

Violle Actinometer.—A large spherical double-walled enclosure filled with water is kept at a known constant temperature. A spherical blackened-bulb thermometer lies at the center of the enclosure, and the sunlight is introduced to it through a suitable vestibule in the double-walled chamber. Violle's method of reading was static, as opposed to the dynamic methods we have just considered. He observed the total rise of the thermometer and its fall after the cutting off of the sun rays, noting the position of the column at fixed intervals after exposure and after closure. The theory of the instrument as developed by Violle is simple and elegant. As a standard the instrument is open to the objection that the water equivalent of the bulb of the thermometer is very small, and difficult to measure, and that several corrections rather difficult of determination should be applied. It was used by Dr. Langley in his expedition to Mount Whitney in 1881.

Ångström Electrical Compensation Pyrheliometer.—This instrument has had the most extensive adoption in recent years of any form of instrument for measuring the solar radiation. It was invented about the year 1895. Two metal strips exactly similar to one another, and blackened upon the front, are exposed alternately to heating by the sun. Arrangement is provided for passing an electrical current through the strip which is not at the moment being heated by the sun. Thermo-elements fastened to the back of each strip indicate when the temperature of the exposed strip is equal to that of the strip which is electrically heated. Under these circumstances it is assumed that the energy of the electric current is equal to the energy received from the sun. About 160 copies of this electrical compensation pyrheliometer have been sent out from Upsala to different parts of the world.

Several other kinds of pyrheliometers have been used in recent years, among them two forms which have been devised by the writer. We shall have occasion to speak of these later.

EARLY OBSERVATIONS

Forbes observed with the Herschel actinometer in the year 1832 at Brientz and the Faulhorn. He showed that the transmissibility of sun rays continually increases as the length of path of the ray in air increases. Forbes rightly attributed this to the non-homogeneity of the solar radiation, and the inequality of transmission of the different component parts of it. Under such circumstances Bouguer's formula of course can not apply. Forbes concluded that equal barometric columns of air give equal transmission, whether taken from the high or low station. In this he was wrong. He formed an empirical curve to represent all his observations at both stations, employing air masses as abscissæ and actinometer readings as ordinates. Instead of extrapolating this curve directly to air

mass zero he preferred to find its tangents and thus derive the subsidiary curve of tangents from which he derived a formula for extrapolating his observations. In this way he obtained results corresponding to the value 2.85 calories per square centimeter per minute for the solar constant. Thus Forbes cut loose entirely from Bouguer's exponential formula of atmospheric transmission.

Pouillet observed in the years 1837 and 1838 at Paris. His work was published before that of Forbes, although made later. He found transmission coefficients by means of Bouguer's formula. He apparently did not investigate the defects of this formula as thoroughly as Forbes did. His result for the solar constant of radiation is 1.7633 calories per square centimeter per minute. This value, on account of the nonhomogeneity of the solar rays, is necessarily too low.

Quetelet observed with a Robinson actinometer similar in form to Herschel's, at Brussels from the year 1843 to 1853. These experiments might well repay a critical examination now, not for their value in determining the absolute measure of the solar constant of radiation, but in connection with the variation of the average intensity of the solar radiation from year to year as influenced by volcanic eruptions.

Desains employed a thermopile, and compared the transmissibility of the rays of the sun through a water cell at different stations. He found the transmissibility of solar rays through the water cell always increased by a long preliminary course through moist air. This result is essentially the same as that of Forbes, although obtained in a different manner.

Violle observed at many different stations, including Mont Blanc. His instrument apparently read much too high, as noticed by Langley in the report of the Mount Whitney expedition. He used a somewhat complicated empirical formula of extrapolation, as he was fully cognizant of the defect of Bouguer's formula, as indicated by Forbes. He obtained the following values:

	Outside Atmosphere	Mt. Blanc	Grand-Mulet	Bossons	Paris
Altitude...........	—	4.810	3,050	1,200	60
Barometer...... ..	0	430	533	661	758
Calories	2.54	239	2.26	2 02	1.74

These values should be reduced about one fourth to make them comparable with observations made in recent years at high elevations by many observers. In such a case the value outside the atmosphere would become about 1.9 calories per sq. cm. per minute.

Crova made many observations at Mont-Pellier with his alcohol actinometer standardized against the Tyndall pyrheliometer. He made some attempts to extrapolate his observations to the limit of the atmosphere, but these, like other solar constant values obtained by pyrheliometry alone, are not definitive. Great value, however, attaches to the long series of direct observations continued from the year 1883 to 1900 at Mont-Pellier. These show plainly the influence of the volcano Krakatau and others.

K. Ångström observed with the electrical compensation pyrheliometer at several stations at different altitudes on the island of Teneriffe in the years 1895 and 1896. Some of his measurements were made at the altitude of 3,700 meters, and give direct readings of solar radiation as high as 1.63 calories per square centimeter per minute. Angström declined to determine from these a value of the solar constant of radiation, recognizing that this demanded observations of the solar spectrum as well as pyrheliometric work. In later years he

prepared spectro-bolometric apparatus for this purpose, and made many solar constant measurements therewith at Upsala. These measurements are still being continued there by his successors. It is hoped that this long and interesting series will soon be published.

Passing from this work of Ångström, which belongs in a later period, and omitting mention of valuable pyrheliometric observations by numerous observers in Italy, Switzerland and Russia, which I regret that space forbids me here to discuss, attention must now be directed to the work of Langley, which marked an epoch in this kind of investigation.

LANGLEY'S OBSERVATIONS

Prior to Langley's observations there had been numerous attempts to determine the solar constant, which are well summed up in the excellent little book of Radau, entitled "Actinometrie." It is shown that nearly all observers were in comparative agreement, so far as their actual observations go, and if the transmission of radiation by the atmosphere be estimated by the simple formula

$$A = A_0 p^{B/760 \sec z},$$

which was employed by Pouillet and many others, the value of the solar constant would be found in the neighborhood of 1.75 calories.

But Forbes, Desains, Violle, Crova and others showed convincingly that this equation does not accurately express the diminution of radiation attending the decline of the sun from zenith to horizon, or the descent of the observer from a high altitude to a lower one. Accordingly several empirical formulæ of more complexity were proposed, which, owing to their more numerous constants, could be made to fit the observed variation of the total intensity of radiation under different conditions more closely. By the aid of such empirical formulæ higher values of the solar constant have been obtained. Some of these in our own time have gone as high as 4 calories. Radau however says:

> It is clear that the intensity of the solar radiation outside the atmosphere can not be certainly obtained from experiments which have been made [prior to 1871], for the result depends essentially on the manner of calculation.

This conclusion is still applicable to pyrheliometer measurements not supported by spectrum observations.

The tendency toward high values of the solar constant was powerfully stimulated by the publication of the report of the Mount Whitney expedition by Langley in 1884. As Forbes and Radau had stated, so Langley emphasized and acted upon the fact that the formula

$$A = A_0 p^{B/760 \sec z}$$

applies only to a homogeneous bundle of rays in a pure atmosphere; and the intensity of solar radiation outside the atmosphere can only be exactly determined when the atmospheric transmission coefficients of the rays of all wave-lengths, which go to make up the complex beam of the sun, are separately determined and allowed for. Langley was the first to determine and apply atmospheric transmission coefficients for numerous rays of different wave-lengths in the solar spectrum. For this purpose he invented the bolometer, a delicate electrical thermometer, and observed with it the variation of the intensity of each ray of the spectrum from low sun to high. He found it impracticable to determine the transmission coefficients in the water vapor bands of the infra-red, but assuming that there were no water vapor bands in the solar spectrum outside our atmosphere, he avoided this difficulty by smoothing the spectrum energy curve, which he computed from his bolometric observations to repre-

sent the distribution of solar radiation outside the atmosphere, so as to leave no water vapor bands in it at all. Had Langley stopped with these steps accomplished, he would have left us, as the result of the Mount Whitney expedition, 2.060 calories, the mean value as determined by high and low sun observations at Lone Pine, or 2.220 calories, the mean value similarly determined from observations at Mountain Camp. But, by the train of reasoning given on pages 142–144 of his report, he convinced himself that the exponential formula does not hold for the earth's atmosphere, even for a strictly homogeneous ray. He therefore altered his results by two different procedures, one of which he states was of a kind to give too low a value of the solar constant, and the other too high. By this means he obtained the values 2.630 and 3.505. The mean of these. 3.068, or in round numbers 3.0 calories per sq. cm. per min., he adopted as the solar constant. But in fact, both procedures were calculated to give too high results, and the most probable results of Langley's observations lies below either of them, and is in fact 2.22, or 2.06 calories, according as the work at Lone Pine or Mountain Camp is regarded as the better. In order to recognize this, it is necessary to examine the argument which led him to doubt the accuracy of the exponential formula, as applied to the transmission of homogeneous rays through the earth's atmosphere, but first let us consider the basis of the formula.

We have seen that Bouguer's formula rests on the fundamental assumption that the light is not changed in its nature in passing from one layer to another, so that equal layers take out equal fractions. This is not the case except for homogeneous rays. It is therefore necessary to divide the beam up into parts, each containing rays of approximately homogeneous transmissibility. For this purpose it is necessary to observe the spectrum of the sunlight by the aid of the bolometer or other satisfactory delicate heat-measuring instrument. Even so, it is not possible to observe the transmission of the atmosphere at every wave-length, so as to determine the coefficients of transmission in the fine lines of absorption by water vapor and oxygen which are introduced by the earth's atmosphere. These lines are mainly grouped in the great bands made up of these fine lines which occur in the red and infra-red spectrum, and for them a special procedure must be adopted as was introduced by Langley. In general, however, the bolometer suffices to give us atmospheric transmission coefficients in sufficient number to deal with the gradually changing transparency of the air for rays of nearly adjacent wave-lengths. The proof of the formula for atmospheric transmission for homogeneous rays follows: It will be seen that the formula is one of extrapolation solely, and is not applicable to computations of the transparency at different barometric pressures, unless it be the fact (which is not usual) that the quality of the air from the different stations to the limit of the atmosphere is approximately identical. This indeed may be the case at very high elevations of 4,000 meters and over, but is not the case for ordinary observing stations, so that in the use of the formula of transmission it is generally erroneous to introduce the barometric pressure in the exponent as was done by Pouillet.

PROOF OF FORMULA FOR TRANSMISSION

Imagine the atmosphere to be made up of n concentric layers so chosen in thickness as to produce separately equal barometric pressures, and let the number n be so great that the transparency of any single layer is sensibly uniform, although the layers may differ from each other in trans-

parency by any gradual progression. The index of refraction of air is so near unity that there will be no sensible regular reflection in passing from one layer to the next, and the transmission of each layer may be expressed exponentially by Bouguer's formula, but with different coefficients of transmission for the several layers.

Thus, suppose E_0 to be the original intensity of a beam of light incident upon the outermost layer at the angle whose secant is m.

Then after passing successive layers the remaining intensities become

$$E_1 = E_0 a_1^{m_1}, \quad E_2 = E_0 a_1^{m_1} \cdot a_2^{m_2},$$
$$E_n = E_0 a_1^{m_1} a_2^{m_2} \ldots a_n^{m_n}. \quad (1)$$

The value of the secant of the angle of incidence will change slightly in passing from layer to layer from two causes: first, the curvature of the earth; second, the refraction of the beam in air. These causes produce opposite effects, the first tending to increase the angle of incidence, the second tending to diminish it as the beam approaches the earth's surface. Their combined effect is dependent on the height to which the temperature exercises absorption and on the distribution of density with the height. But it is generally supposed that the absorption of the air above 40 miles from the earth's surface is negligible, and, remembering that the atmospheric density diminishes with the height, it appears that for zenith distances less than 70° the effect of change of the secant of the angle of the incident beam from the outermost to the innermost layer of the atmosphere will not introduce error greater than 1 per cent. Accordingly for zenith distances less than 70° we may write approximately

$$E_n = E_0(a_1 a_2 \ldots a_n)^m. \quad (2)$$

The symbols $a_1, a_2 \ldots a_n$ denote constants (providing no change of transparency occurs during the interval of time in question), and their values are slightly less than unity. We may substitute for their product a single constant, a, itself a proper fraction, and remembering that E_n is the intensity at the earth's surface, above denoted simply by E, we have

$$E = E_0 a^m. \quad (3)$$

LIMITATIONS OF FORMULA

No mention is made in this expression of the barometric pressure, but it is easy to see that an alteration of barometric pressure would *signify*, under the conventions adopted in deriving the formula, a change in the number of layers, n. This would cause an alteration of the quantity a, which is the continued product of the transmission coefficients of the layers, by introducing additional multipliers a_{n+1}, a_{n+} . . . or by the withdrawal of some a_{n-1}, a_{n-1}. . . . Since we have no means of determining the value of the terms so introduced or taken away, there is no means of correcting for change of barometer in the use of the expression (3) and it would, for instance, be impossible to compute, from knowledge of the values of E, E_0, a and m for one station, what would be the value of E at some station of different barometric pressure.

From this we see that the unit of air mass to be taken for each station is the air mass traversed by beams from zenith celestial objects *between the station itself and the outer limit of the atmosphere*, and that the barometric pressure can not be employed in the computation to reduce observations at different stations to a common unit of air mass.

The determination of the solar constant of radiation, based upon the demonstration which has just been given, depends upon the following assumptions:

1. In a homogeneous medium, a homogeneous ray loses a fixed proportion of its intensity in every equal length of its path.

2. The earth's atmosphere may be considered as made up of a great number of layers concentric with the earth, each approximately homogeneous in itself over the area swept through by the solar beam between zenith distances of 70° and 30° during the time required for this sweep of the beam.

3. Surface reflection of the outer boundary of the atmosphere, or the boundaries of its internal layers, is negligible.

4. Except in the known red and infrared atmospheric bands, the transparency varies gradually from wave-length to wave-length, or if atmospheric absorption lines exist, the energy they absorb is inconsiderable.

5. Atmospheric bands do not exist in the solar spectrum outside the atmosphere.

6. The quantity of solar energy beyond $\lambda = 0.3\,\mu$ in the ultra-violet and beyond $\lambda = 3.0\,\mu$ in the infra-red is inconsiderable.

The soundness of these assumptions is best proved by the results of a great number of observations made at sea level and at high altitudes during the last ten years by different observers, but mainly by the staff of the Astrophysical Observatory of the Smithsonian Institution.

DISCUSSION OF LANGLEY'S SOLAR CONSTANT VALUE

With this preliminary we may perceive why the high solar constant value of Langley ought not to be accepted. For this purpose consider lines 26 to 43 of page 144 of the Mount Whitney report, which detail the precise method employed in obtaining what Langley regarded as a minimum value, namely 2.63 calories per square centimeter per minute.

We now proceed to determine from our bolometer observations a value which we may believe from considerations analogous to those just presented, to be a *minimum* of the solar constant, and one within the probable truth. All the evidence we possess shows, as we have already stated, that the atmosphere grows more transmissible as we ascend, or that for equal weights of air the transmissibility increases (and probably continuously), as we go up higher. In finding our minimum value we proceed as follows, still dealing with rays which are as approximately homogeneous as we can experimentally obtain them. Let us take one of these rays as an example, and let it be one whose wave-length is $0.6\,\mu$ and which caused a deflection at Lone Pine of 201. The coefficient of transmission for this ray as determined by high and low sun at Lone Pine and referred to the vertical air mass between Lone Pine and Mountain Camp is 0.976. From the observations at Lone Pine then, the heat of this ray upon the mountain should have been

$$201 \times 1{,}000 \div 976 = 206.0,$$

but the heat in this ray actually observed on the mountain was 249.7, therefore multiplying the value for the energy of this ray outside the atmosphere, calculated from Mountain Camp high and low sun observations (275) by the ratio 2497/2060 we have 333.3, where 333.3 represents the energy in this ray outside the atmosphere as determined by this second process. In like manner we proceed to deal with the rays already used, thus forming column 8 in Table 120.

It is evident that the transmission coefficient determined for the wave-length $0.6\,\mu$ by the aid of high and low sun observations at Lone Pine, represented the mean transmission of a ray of this wave-length through a mass of air containing all the kinds of strata between Lone Pine and the limit of the atmosphere. Such a transmission coefficient would certainly be greater than that which would have been found if the air had all been like that between Lone Pine and Mountain Camp, because the lower layers are least transparent,[8] therefore the value 0.976 could be known, *a priori*, *not* to represent the transmission of the air between Lone Pine and Mountain Camp, but to be certainly greater than the true transmission coefficient for the air between these stations. Accordingly the discrepancy between the computed and observed intensities at Mountain Camp is only what should be expected, and implies no failure of the formula of Bouguer at all; for that formula was used in the computation of the intensity at Mountain Camp just quoted with a coefficient p which was certainly wrong. The argument on which Langley acted may be stated in a plausible form as follows: If Bouguer's exponential formula with the transmission coefficient obtained by high and low sun observations at Lone Pine gives too low a value of the intensity of homogeneous solar radiation for a station within the atmosphere like Mountain Camp, as was shown by actual observation, much more will it

[8] See Table 118 of the Mount Whitney Report.

give too low a value outside the atmosphere. An equally plausible, and equally fallacious argument is the following: It is said that the density of water decreases with increasing temperature at the mean rate of about .00041 per degree from 0° to 100°. Hence its density at 4° should be 0.99836, but observations at 4° prove that water is actually denser at this temperature than at 0°, therefore the supposed decreased density at 100° is a delusion.

SOLAR CONSTANT WORK OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY

The earlier years of the work of the Astrophysical Observatory were devoted to the improvement of the bolometer and the use of it for the determination of the positions of lines in the infra-red solar spectrum. About 1902 attention began to be devoted to measurements of the solar constant of radiation. We approached these measurements with a very much better instrumental equipment than that which had been Langley's in the Mount Whitney expedition of 1881. Soon after the Astrophysical Observatory was founded, about the year 1890, Langley introduced the automatic registration of the galvanometer in connection with the spectro-bolometer, and in the subsequent years the difficulties connected with the use of the recording spectro-bolometer were so far overcome that the solar spectrum could be observed from the extreme ultra-violet end of the spectrum at about $0.3\,\mu$ to a wave-length of about $3\,\mu$ in the infra-red with great ease and accuracy, in an interval of 8 minutes of time. Drift of the galvanometer, which in Langley's expedition to Mount Whitney he has told me often amounted to a meter a minute on the scale, was now so far reduced that a centimeter an hour would be unusual. In fact the bolometer, despite its great sensitiveness, is about as easy to use for this work as an ordinary thermometer is for measuring the temperature of the air.

Our first measurements of the sun's radiation as a whole were made with the Crova alcohol actinometer, and in order to standardize this instrument we constructed a modified Tyndall pyrheliometer consisting of a copper box filled with mercury and having a cylindric bulb thermometer inserted radially into the box. Owing to the difficulty of keeping the small thread of mercury at the proper point for reading purposes in the Crova actinometer, we found it more desirable to develop the pyrheliometer for our purpose. Soon a solid disk of copper with a radial hole large enough to enclose the thermometer bulb was substituted for the box filled with mercury, the use of mercury being limited to insuring a good heat connection between the bulb of the thermometer and the copper of the disk. Some of these copper disk pyrheliometers are still in use on Mount Wilson. About 1909, however, the further improvement was introduced of using silver in place of copper for the disk. A thin steel lining is provided for the hole where the thermometer is inserted, so as to prevent the mercury from alloying with the silver. In these silver disk instruments the thermometer stem, which is introduced radially in the disk, is bent outside the chamber at right angles so as to point towards the sun. The whole instrument is mounted equatorially with a device for moving it by hand to follow the sun from moment to moment. These disk pyrheliometers, either of copper or silver, have now been in use since the year 1906 with great satisfaction. Their constancy over long periods of time leaves nothing to be desired, and the accuracy of observation reaches a small fraction of 1 per cent.

As the disk pyrheliometer is a secondary instrument, it was necessary to develop a

standard primary instrument to compare it with. As early as the year 1904 experiments were begun to produce a pyrheliometer based upon the hollow chamber "black body" type, with a flowing liquid to carry off the heat produced by the absorption of the solar rays within such a chamber. After numerous experiments and long trial the waterflow standard pyrheliometer was fully developed in the year 1910. Later still, another hollow chamber instrument in which the chamber is bathed with stirred water was employed to check the results of the standard water-flow instruments. In each of these types of standard instruments it is possible to introduce electrically known quantities of heat for testing purposes, and in many experiments it has been proved that the test quantities of heat thus introduced may be recovered to within 1 per cent. Accordingly it is believed that the standard scale of radiation has been thoroughly established. The silver disk instruments are standardized by comparing them with such standard instruments, and the standard scale of radiation so produced, which is believed to be accurate to at least ½ of 1 per cent., has been diffused generally over the world by the Smithsonian Institution. About 25 copies of the silver-disk pyrheliometer have been standardized and sent out to Europe, North America and South America for this purpose. The Smithsonian instruments read about 3.5 per cent. above those of Ångström.

Measurements of the solar constant of radiation were begun in Washington in the year 1902 and have been continued at Washington and elsewhere in every succeeding year until the present time. In 1903 it was noticed that the values of the solar radiation outside the atmosphere obtained in Washington were distinctly variable within the limits of about 10 per cent., and as some of the changes appeared to occur between days which were of the highest order of excellence, it was thought possible that these changes might occur in the sun, and not be caused by alterations of the transparency of the earth's atmosphere. To test this possibility, a station was established on Mount Wilson, California, in the year 1905 by invitation of Director Hale of the Mount Wilson Solar Observatory. The station proved to be very favorable for the work, and in 1908 a permanent structure of cement was built there for the use of the Smithsonian Astrophysical Observatory. In the years 1909 and 1910 spectro-bolometric observations for the determination of the solar constant of radiation were also made on the extreme summit of Mount Whitney in California at an altitude of 4,420 meters. At the same time observations were being made at Mount Wilson at an altitude of 1,730 meters. The results from these two stations reduced to outside the atmosphere at mean solar distance, like those which had formerly been obtained simultaneously at Washington and Mount Wilson, were identical within the limit of the accuracy of the determinations. The accuracy of the work at Mount Wilson and Mount Whitney was so great that the average divergence between the observations of the same days was only 1 per cent. At Washington the sky conditions being less perfect, the average divergence from simultaneous solar-constant results of Mount Wilson was about 3 per cent.

EVIDENCES OF SOLAR VARIABILITY OF SHORT IRREGULAR PERIODS

Numerous observations of several years at Mount Wilson indicated a fluctuation in the solar constant values having a range of about 10 per cent. The fluctuations seemed to occur irregularly, sometimes running their course of 10 per cent. or less

within the period of a week or ten days, and at other times keeping nearly constant. It had been shown by the observations made simultaneously at Mount Wilson and at Mount Whitney that the results as reduced outside the atmosphere appear to be independent of the altitude of the observing station on days when the sky conditions appeared to the eye to be excellent. The march of the apparent fluctuation of the solar constant values at Mount Wilson has not been of a hap-hazard character. I mean by this that the values would progress in a definite direction, as for instance from a low value to a high value by steps through several successive days, and then as definitely progress in the opposite direction through other successive days, and do not fluctuate widely from high values to low as would be the case if the irregularities were due merely to instrumental error. Since, then, it appeared that the fluctuations were neither of an accidental instrumental character nor of a character associated with the altitude of the observing station, it appeared most reasonable to conclude that these fluctuations were due to changes in the sun's emission.

To test this important conclusion it appeared necessary to establish a second station, equally favorably situated with regard to sky conditions as Mount Wilson, but so far remote from Mount Wilson that local influences could not be expected to alter the results at both stations in the same direction on the same day. Such a station was established at Bassour, Algeria, in the years 1911 and 1912. Seventy-five days of simultaneous measurement at Mount Wilson and at Bassour were obtained, and of these days about 50 were so far free from the occurrence of clouds or other disturbing influences at *both* stations as to be retained for purposes of comparison. The result of the comparison shows that when high values are obtained at Bassour, high values are obtained also at Mount Wilson and *vice versa.* Thus the fluctuations which have been found appear to be truly existing in the solar radiation outside the earth's atmosphere, for the solar constant values obtained at two stations separated by about one third the circumference of the earth unite in showing them.

VALUE OF THE SOLAR CONSTANT

During the whole solar constant campaign from 1902 to 1913, about 700 measurements of the solar constant of radiation have been obtained, all but three of the values ranging between 1.80 calories and 2.10 calories. The range of these numbers is mainly attributable to the actual fluctuation of the sun itself, though part, especially in Washington work, is due to accidental errors of measurement. The mean value from 690 measurements is 1.933 calories per square centimeter per minute. It is believed that this number represents the average value of the solar constant of radiation for the epoch 1902 to 1913 within 1 per cent. There is still the possibility, however, that an appreciable quantity of solar radiation beyond the wave-length of $0.3\,\mu$ in the ultra-violet has been absorbed by ozone in the higher atmosphere of the earth, and has been impossible of determination at the stations employed. However, from the consideration of the form of energy curve of the sun's spectrum it is improbable that this lost ultra-violet radiation can exceed 1 or 2 per cent.

SOLAR VARIABILITY ASSOCIATED WITH SUN-SPOTS

Besides the short irregular fluctuation of solar radiation above mentioned as having been shown by the simultaneous measurements at Mount Wilson and Bassour,

Algeria, it appears that a long period fluctuation is associated with the sun-spot numbers. This connection is brought out by taking the mean monthly values of the solar constant measurements at Mount Wilson from the year 1906 on, and comparing them with the mean monthly sun-spot numbers of Wolfer for the same period. From such a comparison it appears that the greater number of sun-spots the higher will be the solar constant of radiation, and that an increase of a hundred sun-spot numbers corresponds to an increase of about 0.07 calories per square centimeter per minute in the solar radiation outside the earth's atmosphere. This is a very curious circumstance, when it is recalled that the temperature of the earth is generally lower at sun-spot maximum than at sun-spot minimum, notwithstanding that, if the above result be true, the solar radiation is more intense at sun-spot maximum than at sun-spot minimum. On the other hand, the result is in line with the irregular variability of the Myra type of variable stars.

ATMOSPHERIC TRANSMISSION

In connection with the measurements which have been made of the solar constant of radiation, there have been some interesting by-products. Among these we may mention first the determination of the transmission coefficients of the earth's atmosphere for light of all wave-lengths, including the ultra-violet and the infra-red spectrum, and ranging from wave-length $0.3\,\mu$ in the ultra-violet to wave-length $2.5\,\mu$ in the infra-red. These transmission coefficients have been obtained by the Smithsonian observers at Washington, Mount Wilson, Mount Whitney and Bassour. It is very interesting to compare them with the transmission of the atmosphere as computed according to the theoretical consideration of Rayleigh on the cause of the light of the sky. It is found that by means of these observed transmission coefficients the value of the number of molecules in the atmosphere may be obtained almost as accurately as by the use of the more common laboratory methods for determining the number of molecules per cubic centimeter of a gas of known density. It is found that the theory of Rayleigh connecting the change of transmission with the wave-length is closely confirmed by the observations at Bassour, Mount Wilson and Mount Whitney. Similar measurements of atmospheric transmission for more limited regions of the spectrum have been made by other observers at high altitudes, and these also are found to agree closely with the theory of Rayleigh, and with our own observations.

Not less interesting is the determination of the distribution of energy in the sun's spectrum, and thereby of the probable temperature existing in the sun. The solar temperatures may be inferred also from the value of the solar constant of radiation itself, and the two methods agree substantially in giving the probable solar temperatures as between 6,000 and 7,000 degrees absolute centigrade.

RECENT BALLOON EXPERIMENTS

Notwithstanding the satisfactory state of the theory of solar constant measurements by the method of Langley, depending upon spectro-bolometric observations at high and low sun combined with measurements by the pyrheliometer, and notwithstanding the close agreement between results obtained by this method for many years at stations of differing altitude from sea-level to 4,420 meters elevation, there still exists the possibility that if we could, indeed, go outside the atmosphere altogether we should obtain values differing materially from those above given. So

long as we observe at the earth's surface, no matter how high the mountain top on which we stand, the atmosphere remains above us, and some estimate must be made of its transmission before the solar constant can be determined. Different persons will differ in the degree of confidence which they will ascribe to measurements of the atmospheric transmission, such as have been considered, and there are still some who totally disbelieve in the accuracy of the results thus far obtained, even though they be confirmed by observations at such differing altitudes. Accordingly it has seemed highly desirable to check the results by a method of direct observation by the pyrheliometer, attaching the instrument for this purpose to a balloon and sending it to the very highest possible altitudes. By a cooperation between the Smithsonian Institution and the United States Weather Bureau, experiments for this purpose were made in July and August of the year 1913.

The instruments employed were modified in form from the silver-disk pyrheliometer, which has been described above. As the apparatus could not be pointed at the sun the disk was placed horizontally, and the thermometer was contrived to record its temperature by photography upon a moving drum. The receiving disk was alternately exposed to the sun and shaded by the intervention of a shutter, operated intermittently by the clock work which rotated the drum under the stem of the thermometer. Five instruments of this kind were sent up on successive days. While it was well known that the temperature of the higher air would go as low as —55° C., it was believed that a blackened disk exposed half the time to the direct sun rays, would certainly remain above the temperature of —40°, which is the freezing point of mercury. This expectation was disappointed. Accordingly, owing to the freezing of the mercury in the thermometer, the highest solar radiation records obtained during the expedition were at the altitude of 13,000 meters, although the balloons in some instances reached the altitude of 33,000 meters.

The results obtained, while they have not the same degree of accuracy as those obtained by direct reading of the silver disk pyrheliometer, are yet of considerable weight. All the measurements unite in indicating values of the solar radiation at altitudes of 10,000 meters and higher, which fall below the value of the solar constant of radiation as obtained by other methods, and above the value of the radiation at the summit of Mount Whitney as obtained by different observers with pyrheliometers. It is expected in the coming year to repeat the observations with balloons under much improved circumstances. By aid of electrical heating apparatus it is expected to keep the surroundings of the disks at approximately the freezing temperature, even though exposed to the air at temperatures as low as —55° C. In this way it is hoped to obtain good pyrheliometer measurements as high as it is possible for sounding balloons to go, and possibly to an altitude of 40,000 meters. As the atmospheric pressure at such altitudes is less than 1 per cent. of that prevailing at sea level, the experiments, if successful, may be expected to remove reasonable doubt of the value of the solar constant of radiation.

C. G. Abbot

SETH CARLO CHANDLER

Dr. Seth Carlo Chandler, eminent astronomer, died on December 31, 1913, in his sixty-seventh year after a short attack of pneumonia.

Born at Boston, Mass., September 17, 1846,

the son of Seth Carlo and Mary (Cheever) Chandler, he spent his early childhood in and around Boston. He attended the English high school at Boston, graduating in 1861, but did not pursue a collegiate course as he had already become interested in mathematical computations while still at the high school, being employed upon the computations of Professor Benjamin Peirce. After graduation he joined Dr. B. A. Gould as private assistant and thus obtained his first taste for astronomical subjects. Dr. Gould was at that time busily engaged in developing the longitude-determinations of the Coast Survey, and through him Dr. Chandler joined the U. S. Coast Survey as aid in 1864. Later when Dr. Gould made his historic expeditionary trip to the Argentine Republic, which eventually resulted in the establishment of a national observatory by the Argentine government, Dr. Chandler refused an offer to accompany the expedition in favor of a position as actuary with the Continental Life Insurance Co. of New York, removing to New York City. It was shortly after this that he married Miss Caroline M. Herman, of Boston, on October 20, 1870.

Seven years later he returned to Boston to accept a position as consulting actuary for the Union Mutual Life Insurance Co. of Boston.

But though his life had been thrown into other channels, Dr. Chandler still felt an interest in astronomical subjects, so it was not surprising that with Harvard College Observatory so near at hand, he should have joined the work of the observatory. Astronomers had long felt the need of some system of communicating such discoveries as comets in order that such objects might not be lost through the inability to observe them at any one station. Realizing this need, Dr. Chandler and Mr. John Ritchie formulated a code for the speedy transmission of discoveries by telegraph to observatories all over the United States. Though the system has been revised, it is still being operated by the Harvard College Observatory.

It was during his connection with Harvard College Observatory that Dr. Chandler invented and constructed the almucanter, an instrument for measuring stellar positions.

After the year 1886 he became a private investigator. There are many instances of men who, while deriving their source of income from other professions, have become interested in astronomy, and who have accomplished remarkable results; but among these there is none to compare with Dr. Chandler, whose whole soul seemed wrapped up in his astronomical investigations.

When one considers that he was the author of over two hundred articles, it can readily be imagined what a serious interest he took in his chosen field, and what a hard worker he was. It has been remarked of many authors that they have only written when the spark of genius inspired them. So it was with Dr. Chandler, who at times would take an almost complete rest from his astronomical labors, only to enter one orgie after another of concentrated effort. While under the spell of one of these sieges, nothing could divert him, but once over it he was ready for any form of diversion or entertainment, taking a great interest in many outside affairs.

As an astronomer Dr. Chandler will possibly be chiefly remembered for his work upon variable stars, and for his historic discovery of the variation of latitude. As a result of his discovery of the variation of latitude, international latitude stations have been established at different points of the earth in order to study the periodic shifting of the earth's pole. Dr. Chandler treated a great variety of other subjects with thoroughness.

For his brilliant work he received the Watson medal of the National Academy of Sciences in 1895, and in 1896 he received the gold medal of the Royal Astronomical Society. De Pauw granted him the degree of LL.D. in 1891.

Upon the death of Dr. Gould, founder and first editor of the *Astronomical Journal*, Dr. Chandler assumed the editorship, which he held during the period 1896–1909, resigning at the latter date because ill health prevented

him from performing his editorial duties. Until his health broke down he had devoted not only much time to the *Astronomical Journal*, but considerable aid from his private purse, a truly conclusive proof of his great interest in the *Journal*.

Personally Dr. Chandler was a man of large interests and a ready sympathy. Those who knew him will remember with pleasure his entertaining and brilliant conversation and correspondence. He was possessed of a broad sense of humor and a keen wit, at once a source of delight to his friends and a weapon to be shunned by his enemies.

BENJAMIN BOSS

DUDLEY OBSERVATORY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

REPORT OF THE ASSOCIATE SECRETARY FOR THE SOUTH

THE associate secretary entered upon his duties October 1, 1913. The first work was to prepare a circular letter which was forwarded to each of the 538 members of the association then residing in the territory of the thirteen southern states assigned by the permanent secretary. The text of this letter follows:

Dear Sir: The next annual meeting of the American Association is to be held at Atlanta, Ga., from December 29, 1913, to January 3, 1914.

To insure its success every member must cooperate.

We desire a large attendance and full programs. This is your opportunity to show your loyalty to the Association and your interest in its aims. Make it a point to be present and to participate in the discussions.

The Association has not the membership in our section which it should have. There has never been a time when the active cooperation of scientists was of such importance as it is to-day. The need of such cooperation is especially marked in the South. We need to get together, to exchange views and to stimulate scientific work. We need to exert our collective influence to secure better support for scientific activities, and greater discrimination in the filling of scientific posts.

The Atlanta meeting of the American Association offers an opportunity for southern men of science to show the country at large that a progressive spirit animates our section and that the cause of higher education and scientific research is being fostered among us.

Will you not constitute yourself a committee of one to secure new members and promote the Association's interests this year?

Enclosed are several membership application cards. Others will be supplied on request. Please make an effort to secure new members from among your colleagues, and urge their attendance at the meeting.

A stamped envelope is enclosed for your reply. I shall be glad to address personal letters to any individual whom you may suggest as eligible to membership. Please also make suggestions as to methods of procedure in advancing the work of the Association in your section.

Let each one do his part and the advancement of science in the South will be materially furthered by the Atlanta meeting.

Cordially yours,
Associate Secretary

With this letter there were enclosed two membership application cards and a stamped return envelope.

In addition a list of 37 members was selected from the representative colleges and universities of the southern states. To each of these a special letter was sent, the text of which follows:

Dear Professor: I am endeavoring to assist Dr. Howard in connection with the Atlanta meeting of the American Association, and I wish to request your personal cooperation.

It is unnecessary to urge upon you the importance of the American Association for men of science, and the obligation which rests upon us in the South to make the coming meeting a success. But if we would demonstrate to the other sections of the country that the South takes an active interest in the advancement of science, we must energetically encourage our colleagues to attend the Atlanta meeting.

I am addressing a circular letter to each southern member of the Association, a copy of which I enclose. But I wish to ask of you special assistance in your own institution.

[1] Presented to the Council at the Atlanta meeting.

I find that the following members of your faculty are enrolled in the Association: ———. Will you not mention to each of these the importance of the Atlanta meeting and urge his attendance and participation?

There are doubtless many others in your community who are eligible to membership. We should like to receive all whom you can recommend, and to welcome them at Atlanta. I enclose several membership application cards and will send others on request.

If you will suggest their names, I shall be glad to write them individually, or, if you think it advisable, I can visit your institution at some time in the fall which we can agree upon, for the purpose of interviewing these men personally, and possibly to speak before the men of science in your community.

Will you not write to me in regard to the matter, and let me know just what you think may be the best method for interesting the present members, and increasing the roll from your institution?

Very cordially yours,
Associate Secretary

From these 538 communications 120 replies were received. Of the special letters 24 were acknowledged. Of the total number of replies 44 recommended persons for membership.

The following table indicates the distribution of members and the acknowledgments received.

State	Total Number	Total Acknowledgments	Number Submitting Names for Membership
Alabama	31	9	5
Arkansas	11	3	2
Florida	27	2	0
Georgia	59	15	7
Kentucky	29	3	1
Louisiana	47	7	3
Mississippi	18	9	4
North Carolina	38	12	3
South Carolina	27	8	3
Tennessee	51	19	6
Texas	83	14	3
Virginia	86	10	5
West Virginia	28	6	2
Removed from territory	3	3	0
	538	120	44

Letters of invitation were sent to each person thus suggested for membership in the association. This number was greatly augmented by the names of eligible persons otherwise secured. The total number of such invitation letters was 255. A membership application card and return envelope were enclosed with each letter, also one of the association leaflets of information.

Acceptances were received from 37 to whom these invitations were extended. In addition, 22, who may or may not have been influenced by these communications to members, applied directly to the permanent secretary. The total enlistment for the territory was therefore 59.

These were distributed by states as follows:

Ala.	6	N. C.	4
Ark.	0	S. C.	7
Fla.	2	Tenn.	14
Ga.	4	Texas	8
Ky.	1	Va.	5
La.	5	W. Va.	3
Miss.	0	Total	59

The associate secretary made two trips in the interests of the association. On October 31 the meeting of the Southern Educational Association at Nashville was attended. On invitation of the president, Hon. M. L. Brittain, the secretary addressed a general meeting of the association, urging the cooperation of southern educators in the work of the American Association for the Advancement of Science, and extending a cordial invitation to be present and participate in the Atlanta meeting.

In response to the requests received from institutions, a ten-day trip was undertaken, commencing November 30, during which the following colleges and universities were visited:

University of Mississippi,
Miss. A. and M. College,
Ala. Polytechnic Institute,
Georgia School of Technology,
University of Georgia,
Davidson College, N. C.,
Clemson College, S. C.

At all these, excepting Davidson College, an address was made before the faculties of the institutions. The topic chosen for discussion was that of cooperation among scientists.

The remarks were informal, dealing with various aspects of scholarly work, and the great need of a more active interest in the advancement of science in southern institutions. These gatherings were all well attended and the discussion led in several places to an active participation on the part of various members of the faculties concerned.

In view of the efforts made by the association to stimulate a greater interest in scientific advancement in the south, the results of this campaign have not been as encouraging as they should be. In the opinion of your secretary there are various reasons for this condition of affairs, but too much space would be required to consider them here at any length. A few points may, however, be mentioned to indicate the general status of science in southern colleges and universities:

1. Outside the agricultural experiment stations, scientific research is not usually encouraged. There is a widespread notion that research and teaching are inimical. Since few southern institutions can afford the luxury of men engaged primarily for research, it is commonly agreed to dispense with this feature of higher education and concentrate upon the employment of "good teachers."

2. The teaching hours of the faculties are often considerable. Almost never are they short of 15 periods per week, and sometimes they run as high as 40. The large number of different courses which one man is thus required to undertake, to say nothing of his participation in committee work of various sorts, leaves him with neither energy nor time for research.

3. The salaries paid to professors are usually inadequate. The men are thus unable to get away to graduate institutions on sabbatical leave or during the summer for special work in their respective fields.

4. There is little active competition in the filling of vacancies, since the openings are infrequently made public before the positions are filled. Furthermore, the compensation of full professors is commonly uniform, hence there is no stimulus within the institution for advancement of salary in recognition of activity along research lines.

5. The instructors and younger men of the faculties are often recruited from recent graduates who have had little experience in advanced work and often have not definitely determined upon a university career. They therefore lack the stimulus of advancement in their profession through original work, and fail to appreciate the value of national gatherings of scientific men, as providing inspiration, and affording an opportunity for personal contact with men in their own lines of endeavor.

Respectfully submitted,
R. M. Ogden

December 30, 1913

MINUTES OF THE SECOND MEETING OF THE PACIFIC COAST COMMITTEE

The committee met on February 7, 1914, in Parlor B of the Palace Hotel, San Francisco.

Present: Chairman Campbell, President Branner, Mrs. Moody, Dr. MacDougal, Professors Haskell, Jenkins, Kellogg, Kofoid, Kroeber, Lawson, Leuschner, E. P. Lewis, Martin, Merriam, Sanford, Setchell, Stillman; Professor Louderback representing the Pacific Association of Scientific Societies, and Commissioner Barr representing the Panama-Pacific Exposition.

It was voted that ten should constitute a quorum.

The minutes of the last meeting, as printed in Science, were approved.

It was voted to strike out the word "Coast" in the designation "Pacific Division."

The report of the executive committee, presenting resolutions of policy, was discussed, and with some amendments, finally adopted as follows:

1. It shall be the purpose of the Pacific Division of the American Association for the Advancement of Science to promote the interests of science through formal and definite cooperation with all Pacific Coast scientific societies of good standards already in existence, and to organize sections in necessary lines of work for which no other provision has been made, such sections to be maintained only until the subjects shall be otherwise

provided for by the organization of affiliated societies.

2. The times and places of meeting of the division shall be decided by a committee consisting of a representative of the division and one representative of each of the affiliated societies.

3. The division shall organize or maintain no sections for the presentation of technical programs in the lines represented by affiliated societies. The technical programs shall be organized by the separate societies, with one member of the division council as a member of the program committee of each society.

4. Individual members of societies need not become division members, and division members need not join societies, but the privileges of those members belonging only to the division to present worthy papers in the proper programs and to take part in the discussions should be recognized.

5. All general sessions, public lectures, appointments of committees for general scientific purposes, etc., shall be controlled by officers of the Pacific division.

6. The constituents of the Pacific division shall be the individual members of the American Association for the Advancement of Science living in the territory defined by the original resolution establishing the Pacific division, and such constituent societies existing within this territory as are up to standard and which shall apply for membership and be accepted by the division, all societies at present constituents of the Pacific Association of Scientific Societies to have the privilege of affiliation until July 1, 1916.

The appointment of a subcommittee to draft a constitution for the Pacific Division was referred to the executive committee with power to act.

A special committee consisting of Director Campbell, Dr. MacDougal and Professor Merriam was appointed to select the associate secretary with power to act. (This committee met later in the day and appointed Albert L. Barrows to this position.)

Professor Lawson presented the report of the committee on the time and place of meeting. The report of the committee was finally adopted with some amendments as follows:

1. The American Association for the Advancement of Science should maintain a central office in San Francisco during the time of meeting.

2. The general sessions of the meeting should be held in San Francisco.

3. The evening lectures should be given in San Francisco.

4. The sectional meetings should be held chiefly in Berkeley.

5. There should be one day's session for sectional meetings at Stanford University.

6. The time of meeting should be the first week in August, 1915.

The chairman stated that Director Hale had declined the chairmanship of the committee on scientific program on account of his health, and that a new appointment would be announced later. (President J. C. Branner has since consented to become chairman of this committee.)

Adjourned to meet at the call of the chair.

E. P. LEWIS,
Secretary.

SCIENTIFIC NOTES AND NEWS

PROFESSOR J. H. COMSTOCK, of Cornell University, has received one of the twelve honorary memberships of the Société Entomologique of Belgium.

THE Franklin Institute of the State of Pennsylvania has awarded its Elliott Cresson gold medal to Professor Wolfgang Gaede for his molecular air pump, in consideration of the very great value of this invention for the quick production of vacua beyond those hitherto obtainable.

THE Cameron prize of the University of Edinburgh has been awarded to Professor Paul Ehrlich in recognition of his discovery of salvarsan and other contributions to medical science.

PROFESSOR ERNST NEUMANN, the pathologist of Königsberg, has been given an honorary doctorate of medicine at the University of Geneva on the occasion of his eightieth birthday.

M. HENRI BERGSON, professor of philosophy at the Collège de France, has been elected to membership in the French Academy.

PROFESSOR J. G. FRAZER has been elected a member of the Athenæum Club for "distinguished eminence."

Arrangements are being made for a reception and dinner in honor of Professor Ira O. Baker, '74, of the University of Illinois, at the Hotel LaSalle in Chicago, on March 17. About four hundred are expected to be present and the list of speakers will include some of the most prominent engineers of the west. Professor Baker completes in June, 1914, forty years of active, continuous service as a member of the faculty of the college of engineering of the University of Illinois.

Dr. Wolfgang Ostwald, professor of chemistry in the University of Leipzig, Germany, was given a banquet on February 11, by the Cincinnati Chemical Society and the Cincinnati Society for Medical Research.

Professor J. Paul Goode, of the University of Chicago, has completed the second pair of wall maps in the series upon which he has been engaged for some years. This pair consists of the physical and political North America. The first pair on the physical and political Europe were issued some months ago. There are to be eighteen maps in the series, all of which are nearing completion.

Lewis E. Moore, associate professor of structural engineering at the Massachusetts Institute of Technology, has resigned to become bridge engineer for the Massachusetts Public Service Commission.

Professor Hergesell, head of the Meteorological Institute of Strassburg, has been appointed director of the Aeronautical Laboratory at Lindenberg, in succession to Professor Assmann.

Professor A. A. Iwanow has been appointed director of the University Observatory at St. Petersburg.

Dr. Martin Strell has been appointed assistant in the Biological Experiment Station for Fisheries at Munich.

Professor E. C. Bryant, of Middlebury College, Professor L. L. Campbell, of Simmons College, and Professor W. E. McElfresh, of Williams College, are spending their sabbatical year at the Cavendish Laboratory of Cambridge University, and are carrying on researches under Sir J. J. Thomson.

Professor Henry Tschetschott, of the St. Petersburg Mining Institute, has registered at the Massachusetts Institute of Technology for special work. His coming to the institute is part of a general plan of the government to educate Russians abroad for positions as teachers in the home schools. Already there are at Technology two other Russians, Messrs. Penn and Ortin, who have likewise been sent by the government.

Dean Charles R. Bardeen, of the school of medicine of the University of Wisconsin, delivered the annual address of the University of Iowa chapter of Sigma Xi, February 18, on "The Effect of Physical and Chemical Agents on Development."

Under the auspices of the Rush Society, the College of Physicians of Philadelphia, the University of Pennsylvania, the Philadelphia Pathological Society, and the Mütter Museum, the Weir Mitchell lecture for 1914 was given on February 25, by Dr. Harvey Cushing, professor of surgery at the Harvard Medical School, on "Clinical types of dyspituitarism."

The Harvey Society lecture on February 28, at the New York Academy of Medicine, was given by Professor Richard P. Strong, of Harvard University, on the etiology of oroya fever and verruga peruviana.

"The Nebular Hypothesis" was the subject of an illustrated lecture given on March 2 by Professor Forest Ray Moulton, of the department of astronomy and astrophysics in the University of Chicago, at the Berwyn center of the University Lecture Association, Chicago. On March 16 Professor Moulton speaks at the same place on the subject of "The Sidereal Universe."

Dr. Wolfgang Ostwald delivered his series of five lectures on colloids at the Ohio State University during the week ending February 21. A more popular lecture designed to interest beginners in chemistry was delivered for the benefit of the freshmen class.

The foreign mathematicians who attended the Fifth International Congress of Mathematicians held at Cambridge in 1912 subscribed a sum to be devoted to a permanent

memorial to the late Sadlerian Professor, Dr. Cayley. We learn from the London *Times* that, having in mind that the presidency of this congress was the last public appearance of Sir George Darwin, his colleagues in the administration of the congress have desired to provide a memorial of his work in the same connection. Accordingly a brass plate with armorial decorations has been prepared, and is now offered by Sir Joseph Larmor on behalf of his colleagues to the university. It is proposed to fix this brass in the chief mathematical lecture-room in the new lecture-rooms building.

Mr. H. B. Woodward, F.R.S., formerly assistant-director of the British Geological Survey, died on February 6, aged sixty-five years.

Major G. E. H. Barrett-Hamilton died on January 17 in South Georgia, where he was conducting an investigation into the whaling industry on behalf of the Colonial Office and the British Natural History Museum.

Dr. Karl Bölckers, professor of ophthalmology at Kiel, has died at the age of seventy-eight years.

We regret also to record the death of M. Alphonse Bertillon, the distinguished French anthropometrist.

The Russian minister of public instruction has made a grant of $50,000 to the St. Petersburg Academy of Sciences to assist a search for radio-active minerals throughout the Russian Empire.

Canada has established a forest products laboratory in connection with McGill University at Montreal, on the lines of the United States institution of the same sort at the University of Wisconsin.

Provision is to be made in connection with the French department of war for continuing the aerological work carried on by the late M. Léon Teisserenc de Bort, at his observatory at Trappes.

The annual general meeting of the American Philosophical Society will be held on April 23, 24 and 25, 1914, beginning at 2 P. M. on Wednesday, April 23. Members are requested to send to the secretaries, at as early a date as practicable and before March 5, 1914, the titles of papers which they intend to present so that they may be announced on the *preliminary* program which will be issued immediately after that date and which will give in detail the arrangements for the meeting. Papers in any department of science come within the scope of the society which, as its name indicates, embraces the whole field of useful knowledge. The publication committee, under the rules of the society, will arrange for the immediate publication of the papers presented in either the *Proceedings* or the *Transactions*, as may be designated.

The fifth International Congress of Philosophy will be held in London beginning on August 31, 1915, under the presidency of Dr. Bernard Bosanquet. The sections proposed are: (1) General Philosophy and Metaphysics. (2) Logic and Theory of Knowledge. (3) History of Philosophy. (4) Psychology. (5) Æsthetics. (6) Moral Philosophy. (7) Social Philosophy and Philosophy of Law. (8) Philosophy of Religion. All communications should be directed to the honorary secretary of the congress, Dr. H. Wildon Carr, More's Garden, Chelsea, London, S.W.

The territory within a mile or two of each of the mouths of the Mississippi is characterized by large swellings or upheavals of tough bluish-gray clay, to which has been applied the name "mud lumps." Many of these mud lumps rise just offshore and form islands having a surface extent of an acre or more and a height of 5 or 10 feet, but some do not reach the water surface. These mud lumps, in addition to being of importance because of their effects on the channels of the Mississippi River, are also of considerable scientific interest, for their development is not included in the usual conception of delta growth, and although several theories have been advanced, their cause must still be regarded as uncertain. To an observer at the mouth of the river the idea that the region is a great dumping ground for a large part of the United States is most impressive. The land is being built out into the sea at an estimated average rate of about 300 feet a year; in some places the rate is much more rapid than in others. In

one place in Garden Island Bay the land appears to have advanced 2,000 feet in the spring of 1912. The mud lumps are commonly 20 to 30 rods broad and stand 20 or 30 feet above the adjacent bottom. Their growth occupies from a few hours to several years and is usually irregular. Generally a mud lump rises in a few weeks or months to a height of 4 or 5 feet above the surface of the water. Then it remains quiet and is beaten down by the waves in the course of a few years. Many of them subside, however, and some disappear over night. Those that rise slowly are considerably worn before they stop growing, while those that rise more rapidly and in protected places are capped by laminated silt having a maximum thickness of 10 feet. Among the most conspicuous and impressive features of the mud lumps are the mud springs that are active on many if not all of them. The discharge from these springs consists of salt, watery mud and gas—in fact, gas escapes at many places on the surface of the Delta of the Mississippi, the vents appearing to be most numerous and largest on and near the mud lumps, though the rate of flow rarely, if ever, exceeds a few cubic feet an hour. Gas rises in bubbles in all the mud springs, though its rate of issue varies. The United States Geological Survey has issued a report entitled "The Mud Lumps at the Mouths of the Mississippi," by Eugene Wesley Shaw—a copy of which may be obtained free on application to the director of the survey, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

The observance of Washington's birthday at Lehigh University was marked by the dedication of Coppee Hall, the new home of the arts and science department. The building is named after Dr. Henry Coppee, who was the first president of Lehigh University.

Teachers College, Columbia University, celebrated its twenty-fifth anniversary on February 20 and 21, with an educational conference which brought together nearly one thousand alumni and former students of the institution. During Friday and Saturday a series of educational conferences was held at the college devoted to different divisions of the educational fields as follows: Administration and College Teachers of Education, Secondary Education. English, History, Geography, German, Mathematics, Science, Elementary Education, Kindergarten Education, Fine and Industrial Arts, Household Arts, Nursing and Health, Household Administration. The speakers included superintendents of schools, deans of university schools of education, directors of normal schools and specialists from various educational fields, college, secondary and elementary. Saturday night nearly 800 alumni gathered for a dinner at the Aldine Club. The program of the science round table was as follows:

"Use of Literature in Science Teaching," by Clarke E. Davis.

"Trend of the Times," by J. Newton Gray.

"A Method for Teaching Nutrition in the High School."

"Chemistry for Second-year High School Girls," by Henry T. Weed.

"General Science—A Method and Its Difficulties," by Roland Hugh Williams.

"An Experiment in Teaching Heat," by Carl J. Hunkins.

Professor A. L. Dean, of the Sheffield Scientific School, Yale, has accepted the call to the presidency of the college of Hawaii, at Honolulu, and will take up his duties there next autumn.

At the Massachusetts Institute of Technology Mr. J. M. Barker has been appointed instructor in civil engineering and Miss Edith A. Beckler, lecturer on public health laboratory methods.

Dr. H. F. Baker, F.R.S., fellow of St. John's College and Cayley lecturer in mathematics, has been elected Lowndean professor of astronomy and geometry in the University of Cambridge in succession to the late Sir Robert Ball.

The Manchester University Council has appointed Dr. Charles Alfred Edwards to the chair of metallurgy and metallography.

Dr. E. E. Fournier d'Albe, assistant lecturer in physics in the University of Birmingham, has been appointed special lecturer in physics in the University of Punjab, Lahore.

DR. LUDWIG DIELS, of Marburg, has been appointed associate professor of botany in the University of Berlin, and assistant director of the Botanical Garden and Museum.

DISCUSSION AND CORRESPONDENCE

FOSSIL PLANTS IN THE PANAMA CANAL ZONE

EXCEPT for the incidental mention by Pilsbry and Brown of lignified nuts in their paper on the Mollusca I know of no record of any remains of fossil plants having been found in the Canal Zone, notwithstanding the fact that the numerous Tertiary tuffs would seem to furnish an admirable matrix for the preservation of leaf impressions.

During 1912 Dr. M. I. Goldman, of the Johns Hopkins University, visited the Isthmus and in connection with his work on rock weathering devoted considerable time to a search for fossil plants along the Canal with the results indicated by the following note.

Since fossil plants of Tertiary age from the tropics have not been collected or studied to any large extent and since the Tertiary floras of Central America have a most important bearing on both the phytologic and geologic history of southeastern North America during the Tertiary, a preliminary announcement seems justifiable.

Fossil plants seem to be somewhat sparsely but widely distributed along the canal and identifiable forms were collected from the following localitites:

1. East wall of the Culebra Cut just north of station 1760 and opposite Culebra.

2. West wall of cut below Miraflores locks, where the plant-bearing tuff outcrops for about one fourth of a mile.

3. Culebra Cut under the steep hill just north of Paraiso, associated with specimens of the pelecypodian genus *Phacoides*.

4. Gatun Dam borrow pits.

The best material comes from the first of these localities and the least satisfactory from the last. The collections have not been critically studied, since it is hoped that more extensive collections will be sent in by the resident geologist of the Canal Commission.

The following forms have been recognized in a preliminary study of the collection: A fine large species of *Guatteria* which is present at several localities; a well-marked species of Myrtaceæ, probably representing the genus *Calyptranthes;* a species of *Nectandra;* a species of *Rhamnaceæ;* a characteristic small-leaved species of *Ficus;* another of *Ocotea;* a species of *Rubiaceæ* and one of *Melastomaceæ.* Petrified wood was also collected and although but three slides have been cut these show apparent identity with a species described from the Oligocene of the Island of Antigua.

None of the material lends any support to the view, at one time prevalent, that some of the Isthmian beds represent deposits of Eocene age, and while the various plant-bearing beds are probably not exactly synchronous, their floras in so far as they are known from the present small collection all appear to be referable to the Oligocene.

EDWARD W. BERRY
JOHNS HOPKINS UNIVERSITY,
BALTIMORE, MD.

WHAT GRADES REPRESENT

THE following considerations have been of service to the writer in the diagnosis of the difficulties encountered by students in meeting the scholastic requirements represented by grades, and the identifying of the obstacles has often assisted in their removal.

It is not necessary in this discussion to assume any more definite or uniform system of grading than that 100 per cent. represents a perfect grade and that there is a minimum grade required to entitle the student to credit for the course. Half way between these is what may be called an average grade. This does not mean the grade that a class would average under the usual conditions, but what a class might be expected to average if all members gave all the officially allotted time (or a reasonable time) and their best effort to the subject—quite a different matter! The instructor should make his demands such that the student of average qualifications using his best effort all the allotted time would receive the average grade—half way between the passing grade and 100 per cent.

The main factors represented by grades intelligently given may be described by the six terms: time, effort, mental ability, memory, language sense and preparation. The relative importance of these factors varies widely with the nature of the subject, but all are involved in every intellectual pursuit. The order chosen is that of directness of control by the student.

Time.—This includes both that in attendance on classes and that given to the subject outside of class hours. Irregularity of attendance on classes and deficiency of outside preparation would have their obvious results in this factor, irrespective of the reasons for such irregularity or deficiency.

Effort.—This factor includes the practise of concentration in and out of class, largely a result of past habits; thoroughness of thought, which passes nothing until really grasped; and system, which insures sustained and continuous work as opposed to cramming at intervals.

Mental Ability.—This is evidenced by the ease and accuracy with which new ideas are grasped. It is of course largely a natural endowment, developed, however, or allowed to deteriorate, slowly by its exercise or its disuse. This factor is most important in subjects of a strongly reasoning character.

Memory.—By this term is meant the retaining of ideas rather than the memorizing of words or symbols; it is mainly a natural endowment but somewhat subject to cultivation by mental activity.

Language Sense.—By this is meant the ability to understand and to use language with precision. It is probably to some degree a natural gift, but is also largely a result of early training and associations and an appreciation of its importance. The student who can not express his own ideas clearly usually receives only vague impressions from his oral or printed instruction. The language sense can be cultivated by sustained effort directed to that end.

Preparation.—This includes general education along intellectual lines, to which appeal can be made for analogies and illustrations. It also means a proper command of the earlier part of the same subject and of other subjects directly used as foundational material and as tools; grades wisely given in these antecedent subjects indicate clearly the adequacy of this direct preparation. It is in this factor that the student who has habitually aimed at passing rather than grasping his curriculum encounters the natural consequences in his increasing difficulties.

In conclusion it may be noted that time and effort are under immediate control; mental ability, memory and language sense are subject to slow cultivation; and preparation is beyond present control. Of course less than all the allotted time, or less than the student's best effort, or less than an average rating in factors, would necessitate correspondingly higher values for the other factors that an average grade might be earned.

P. N. Evans

Purdue University,
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SCIENTIFIC BOOKS

Elementary Studies in Botany. By John M. Coulter, A.M., Ph.D., Head of the Department of Botany, University of Chicago. New York and Chicago: D. Appleton and Company. 12mo. Pp. ix + 461.

It is a pleasure to note the gradual approach to a standard course of study in botany for the high schools of the country, and there can be no question that such an approach to standardization is occurring if one will look over the text-books prepared during the last few years. Especially is this tendency marked where the authors combine a considerable experience in the teaching of botany with a comprehensive knowledge of the science. The book before us is an excellent illustration of this fact, which the author recognizes in the opening paragraph of his preface, and which is so good that we quote it complete. "It is seven years since 'A Text-book of Botany' was published, and during this period there has been not only great progress in the knowledge of plants, but also much discussion concerning the effective use of plants in high school education. It is natural that a discussion of this kind should lead to considerable

diversity of opinion, and it is evident that no one is in a position as yet to decide the points at issue. Amid all the flux of opinion, however, there is evident a desire to relate plants more closely to the interest and to the need of high school students. This desire expresses itself in an extreme form when courses in 'agriculture' are asked to be substituted for courses in 'botany.' This has brought a distinct temptation to publishers and to authors to 'meet the demand' without much consideration as to its significance. It can not mean that all that has proved good in the older method is to be abandoned, and an unorganized mass of new material substituted for it. It can not mean that high school pupils are to become apprentices rather than students. It must mean that the structure and work of plants are to be so studied that this knowledge will enable the student to work with plants intelligently. In other words, it is intended to be the practical application of knowledge, rather than practical work without knowledge."

It would be well for teachers of botany of all classes to carefully read these sentences, which gain in strength and significance to the end of the paragraph. As the writer of this review has insisted over and over again, botany wherever taught must be botany, and not some application of botany, or some study of plants not involving the orderly sequence of structural and physiological inquiry. Agriculture, horticulture, plant breeding, forestry, etc., are most excellent subjects of study for young people (and older people, for that matter), but they are not botany; rather, they require botany as a prerequisite, and must be based upon it.

Coming to Dr. Coulter's text-book we find twenty-seven chapters arranged in two "parts." Chapters I. to XIV., inclusive, deal with what may be called "pure" botany, and in these the pupil is taken step by step from the simpler to the more complex plants and their principal functions. This part of the book is intended to afford a good half-year's work for the high school pupils, and without doubt this is one of the best formulations of this work which has yet appeared. In looking through the chapters one finds nothing which can well be omitted, nor anything which imperatively demands admission. In the second part, which is entitled "Plants in Cultivation" one finds also not a little of pure botany. Thus the chapter "What Plants Need" is plant physiology, pure and simple, as is also the chapter on "What the Soil Supplies." There is a little concession to the "practical" in the chapters on "Seeds," "Other Methods of Propagation" and "Plant Breeding," and considerably more in those on "Cereals and Forage Plants," "Vegetables," "Fruits," etc., and yet in even the most "practical" of these one sees that the presentation is by one who is primarily a botanist. All through this second part the living plant *as a plant* is emphasized, rather than the plant as a crop to be sold for such and such a sum. And here is perhaps the line of difference between the scientific conception of plant study and the conception held by those who think of plants as things to be grown for our use or pleasure. Dr. Coulter's book is a demonstration of the possibility of presenting much of applied botany in a scientific manner.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

The Evil Eye, Thanatology and Other Essays. By ROSWELL PARK. R. G. Badger, Boston. 1913.

This volume consists of a series of entertaining essays, which, as the author states, "partake of the character of studies in that border-land of anthropology, biology, philology and history which surrounds the immediate domain of medical and general science." The subjects include The Evil Eye, Thanatology (the study of the nature and causes of death), Serpent Myths and Serpent Worship, Iatro-Theurgic Symbolism, Giordano Bruno, The Career of the Army Surgeon, The Evolution of the Surgeon from the Barber, History of Anesthesia and the Introduction of Anesthetics in Surgery, etc. The treatment in nearly every case is primarily historical, and the main purpose appears to be to show how many

customs and ideas of to-day have roots in the past which are hardly suspected by the general public. On the whole, the book makes melancholy reading, unless one can enjoy the contrast between ancient follies and our own astonishing superiority! The study of past error and confusion is certainly of value as exhibiting the weak spots in our social organism, and enabling us to be on our guard against early symptoms of decay in the societies to which we belong. Thus, the author says:

"If one attempt to scan the field of the history of medicine, to take note of all the fallacies and superstitions which have befogged men's minds, and brought about what *now* seem to be the most absurd and revolting views and practises of times gone by, and if one search deliberately for that which is of curious nature, or calculated to serve as a riddle difficult of solution, he will scarcely in the tomes which he may consult find anything stranger than the close connection, nay, even the identity maintained for centuries, between the trade of the barber and the craft of the surgeon. Even after having studied history and the various laws passed at different times, he will still miss the predominant yet concealed reason for this state of affairs. This will be found to be, in the words of Paget, the 'maintenance of vested rights as if they were better than the promotion of knowledge.'"

It is impossible to contemplate this history without asking whether to-day the "concealed reason" mentioned by Paget is not still powerful, and serving to prevent our academic institutions from readily adapting themselves to their social environment. From another point of view doubt may be expressed as to the complete validity of the author's historical method. From time to time we find fault with the professional historian, who, depending on documentary evidence, seems to over-emphasize the miseries and stupidities of former days. We like better our Morris and Scott, who offer us pictures of moving life, full of romance, adventure and high ideals. It is easy to criticize such writings, as we criticize the landscape artist who makes idyllic pictures of suburban lanes, leaving out the tin cans, dead cats and evil smells. Yet after all, life was life in those days, and the best that is in us calls across the ages to the best that equally existed in our ancestors. Dr. Park's accounts may be true as to facts, and yet to some extent misleading to those who have not other sources of information.

T. D. A. Cockerell

BEETLES BECOMING PARASITES

In all the great group of beetles, 50,000 species strong, and of an extraordinary variety of external appearance and of habit, witnessing to a ready plasticity and adaptiveness, there are but few indications of a resort to parasitism as a shift for a living. The Stylopidæ, it is true, are parasites (in the bodies of wasps, bees and leaf hoppers), but these insects are no longer considered to be aberrant beetles, but to constitute a quite distinct order, more nearly allied to the Hymenoptera or Diptera than to the Coleoptera.

The classic and single conspicuous example of a parasitic beetle, living all of its life (both larval and adult) on its host, is the well-known beaver parasite, *Platypsylla castoris*, common both in Europe and America. This insect lives as an external parasite among the hairs on the outside of the host's body, and feeds on the hairs and dermal scales, just as the Mallophaga (biting bird lice), of birds and mammals, do. It has a highly modified body, and is the only species of its genus and family.

Another small beetle, however, *Leptinus testaceus*, of the family Leptinidæ, is known in both Europe and America as a frequenter of the nests of field mice, shrews and other small mammals of similar habit. It has also been taken from bumble bees' nests. I have recently received several specimens of this beetle which were taken from the bodies of freshly killed shrews on Forrester Island, Alaska, by Professor Harold Heath. The beetle's body is not modified (by flattening, fusion of thoracic segments, etc.) in any such extreme way as is that of Platypsylla or the Mallophaga, but it shows, nevertheless, the

beginnings of such adaptive modification, and suggests plainly that the beetle's habits are probably already those of a habitual external parasite of its shrew and field mouse hosts, feeding (with simple biting mouthparts) on the dermal scales and hair.

Professor Van Dyke, of the University of California, our foremost Pacific coast student of the beetles, and from whom I have most of the information used in this note, writes that from the fact of finding *Leptinus* in the nests of bumble bees a number of entomologists have advanced the idea that the beetle lives normally in bumble bee nests and becomes accidentally carried from them by mammals that raid the nests. "This I do not agree with," says Dr. Van Dyke. Considering all of the circumstances of the few captures that have so far been made of the beetles, Dr. Van Dyke concludes that the beetle is a real parasite of the mice and shrews and "absolutely dependent on them in the same way that the Mallophaga are dependent on their hosts."

Another little beetle, *Leptinillus validus*, closely related to *Leptinus*, occurs on beavers in the Hudson Bay region. Still another beetle, *Lyrosoma opaca*, a Silphid (carrion beetle), is found in the North Pacific upon practically all of the islands and isolated ocean rocks to be found there. It breeds in rotten kelp and among old and broken murres' eggs, etc., and has been found prowling about the tenanted nests of the murres. But it is wingless, and Dr. Van Dyke believes that it is carried from island to island and rock to rock by the roosting and breeding birds of these rocks and islands, the beetles accidentally seeking shelter among the feathers of brooding or perching birds, and thus being carried off by them when they take to flight. "Only in this way," writes Professor Van Dyke, "can I account for the presence of the beetles on Bogoslov Island [the famous recent volcanic island of Alaska], for this island is but little over one hundred years old, and the insects are so delicate that they could not possibly survive longer than a few minutes in the Arctic waters."

These stages in the change from a scavenger's life to that of an external parasite, shown by the series of beetles referred to in this note, are exactly parallel with the transition stages from the wingless Atropids (Procidæ) feeding on dry bits of dead organic matter, even to the feathers and organic detritus in birds' nests, to the Mallophaga, feeding on the same bits of feathers and dermal scales, but finding them on the bodies of the birds themselves, to whom they have come to bear the relation of permanent external parasites, with no longer any capacity to live off their hosts. The next step for some of the beetles to take would be to become like the Anoplura, and find a more acceptable food in the blood of the hosts. For this their mouthparts would have to be considerably modified, but that would be no difficult matter.

VERNON L. KELLOGG

STANFORD UNIVERSITY, CALIF.

SPECIAL ARTICLES

THE DECOMPOSITION OF SOIL CARBONATES

IT has been found at the agricultural experiment station of the University of Tennessee, that excessive amounts of magnesium carbonate were entirely decomposed when left in contact with fallow soils in pots protected from leaching. Three types of soil were used, and the amounts of chemically pure precipitated carbonate of magnesia, equivalent to 16,000 pounds per acre of calcium carbonate were applied, in excess of the lime requirement, as indicated by the Veitch method. One year after the application the soils were analyzed and found to be strongly alkaline, but practically free of carbonates. Repetition of the experiment in metal rims, using 32,000 pounds of magnesium carbonate per acre, under field conditions, afforded the same observation in every one of eight treatments, four with magnesium carbonate alone and four with carbonate supplemented by manure, the analyses being made in this series after an eight weeks' period of contact. This work was begun in the spring of 1912 and final analyses were made in August, 1913.

It has hitherto been held that the conver-

sion of calcium and magnesium carbonates into silicates in soils has been due entirely to replacement of sodium and potassium and other bases in polysilicates. The writer and associates will shortly present in bulletin form conclusive evidence that magnesium carbonate reacts with and is fixed by silica (SiO_2), and that calcium to a less degree acts in the same manner.

Titanium oxide, which chemically is closely allied to silica and which is usually present in soils, was found to bring about the same decomposition as silica. The evidence secured points strongly to the nonexistence of magnesium in the form of carbonate in soils of humid climates.

It is believed that this research will throw considerable light upon the use of dolomite in farm practise.

W. H. McINTIRE
AGRICULTURAL EXPERIMENT STATION,
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February 16, 1914

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION C—CHEMISTRY

ON the forenoon of Wednesday, December 31, joint sessions of Sections B and C were held in the Georgia School of Technology, with Vice-president Cole, of Section B, in the chair. The purpose of the meeting was a discussion of geochemical and geophysical topics; it is referred to further in the report of Section B.

The main sessions of Section C were held at the Winecoff Hotel on Thursday, January 1, with Dr. C. L. Alsberg, vice-president of the section, in the chair. This was a joint meeting with the Georgia Section of the American Chemical Society, the secretary of which had assisted in arranging the program. There was an attendance of between fifty and sixty, and considerable interest was evinced in all of the papers presented. In the evening a smoker—which indeed partook rather of the nature of a dinner—was tendered to the visiting chemists by the Georgia Section of the American Chemical Society; a number of topical verses and songs were sung and the whole affair was most enjoyable. The secretary desires to record here on behalf of the visiting chemists their appreciation of the hospitality of the Georgia Section and to express thanks to it and to its secretary, Mr. J. S. Brogdon, for contributing so much towards the success of the meeting.

A brief account of the proceedings is appended.

The following resolution, presented by Professor Charles E. Munroe, was carried unanimously:

WHEREAS the Committee of this Section on Nomenclature and Notation presented at the Indianapolis meeting a report through its chairman, Dr. J. Lewis Howe, affirming the validity of the name and symbol columbium, Cb; and,

WHEREAS this report was accepted and adopted by this section; and,

WHEREAS the Committee on Inorganic Nomenclature of the International Association of Chemical Societies has reported on September 22, 1913, favoring the namo and symbol niobium, Nb, for the element which was named columbium by its discoverer; and,

WHEREAS a later detailed investigation of the historical record by Dr. F. W. Clarke, a copy of the results of which is filed herewith,[1] finds no valid reason for the use of the name niobium;

Therefore be it resolved that we reaffirm our endorsement of the report of the committee of this section and view with regret this action of the committee of the International Association of Chemical Societies in advocating the use of the later name, thus introducing confusion where simplicity is sought.

Following this a vote of thanks, proposed by Professor Brackett and carried unanimously was accorded to the authorities of the University of Virginia, and in particular to Professor F. P. Dunnington, for their courtesy in allowing samples from their collection of the explosive materials used by the Confederacy during the War to be forwarded to Atlanta for use as illustrative material for Professor Munroe's lecture.

The Cause of Osmotic Pressure: W. V. METCALF.

After summarizing the different theories which have been advanced, the author presented a statement and defense of Le Blanc's theory, which, though the best explanation yet offered, has up to this time not attracted as much general attention as it deserves. On this theory osmosis is considered to result from the different internal pressures of solution and solvent, the internal pressure being the resultant of the normal components of the unbalanced molecular attractions at the free surface of the liquid.

Some Possibilities of Georgia Clays: CHARLES L. PARSONS.

In the state of Georgia all kinds of clays are to be found, so that there is no reason why all sorts of clay products should not be manufactured

[1] This has already appeared in SCIENCE, 39, 139–140 (1914).

there. Three kinds are of especial importance: the bauxite deposits, fuller's earth, and highly aluminous clays suitable for high refractories; all are of better quality than is commonly found elsewhere, and only require proper technical investigation and control to insure their successful commercial utilization.

Permeability Measurements as an Aid in Proximate Organic Analysis: A. M. MUCKENFUSS.

A general discussion of a method of measuring the relative permeability of films (*e. g.*, of paint or oil) to water vapor, and of the usefulness of such results as an aid in characterizing the film or membrane. The apparatus and method have been described previously.[1] As an example of the results obtainable, curves illustrating the effect of the presence of menhaden, tung or corn oil in films of linseed oil were shown.

Manufacture of Carbon Dioxide and Its Incorporation into Water: W. P. HEATH.

For the production of carbon dioxide on a commercial scale five methods are employed; most usually it is done either by combustion of coke in a special furnace, or by the action of acid on marble or dolomitic limestone. Some anomalous effects have been observed in the behavior of aerated waters as ordinarily made—for instance, that the pressure inside a freshly charged bottle may increase considerably; these effects are attributed to admixture of air with the carbon dioxide.

Walnut Stain in the Killing of Fish: G. P. SHINGLER.

Green walnuts or oak bark thrown into water will kill fish very quickly. Investigation of this question showed that in either case both narcotin and tannin are present in the solution and indicated that the latter is the active poisonous agent.

Sanitary Water Analysis in Relation to Public Health: RAY C. WERNER.

A plea for the importance of thorough control of water supplies, for the need of education in regard to this matter, and for effective inspection of filtration plants, together with regular tests—both chemical and bacteriological—of the water as delivered to the consumer.

Cotton Seed Meal as a Possible Food for Man: C. A. WELLS.

A general discussion of the possible utilization of cotton seed meal as a food for man, of its digestibility and toxicity, and of its food value, especially with regard to its cheapness as a source of protein.

Studies of the Chemical Composition of Cotton Seed: C. L. HARE.

A record of work at the Alabama Experiment Station which was undertaken in order to ascertain whether it would be possible by breeding cotton to improve the seed in the direction of a larger oil content and higher protein content, though of course without prejudice to the amount and quality of the fiber; but up to the present little definite progress has been made. Apparently there is no relation between the amount of lint and that of oil or protein; but the amount of oil seems to bear some relation to the weight of the seeds, to the percentage of protein, and, possibly, to the amount of inorganic constituents.

Occurrence and Composition of Some Alabama Phosphates: B. B. ROSS.

Large quantities of phosphate-bearing strata are found in Alabama, apparently closely associated with a thick bed of rotten limestone and with green sands; their formation is ascribed to a leaching of this phosphatic limestone. This view is confirmed by analyses of boulders, which showed that the weathered layers contain considerably less phosphate than the unweathered portion. Much of this phosphate deposit could not be worked economically at the present time, but it may be capable of later development when other fields become partly exhausted. The green sands contain both potash and phosphate, and many possess local value as a fertilizer.

Rubber Substitute from the Holly: CHARLES P. FOX.

According to a recent French invention a rubber substitute may be made from the holly. Similar experiments with American holly showed that the amount of extract is too small to be remunerative; further, that addition of this extract to reclaimed rubber delays vulcanization, increases the elongation and permanent set, but does not increase its tensile strength.

Mexican Petroleums: MORRIS O. GOTTLIEB.

Chemistry in Relation to the Development of the Fertilizer Industry: J. S. BROGDON.

An Incompatibility in Fertilizer Mining: T. E. KEITT.

When basic slag is mixed with muriate of potash or kainit a large proportion of the potash becomes insoluble in water. The insoluble compound thus formed is very slightly soluble in neutral am-

[1] *J. Ind. Eng. Chem.*, July, 1912.

monium citrate of sp. gr. 1.09, and only slightly soluble in citric acid, but is readily soluble in hydrochloric acid of sp. gr. 1.115.

Two Partially Compensating Sources of Error in the Official Method of Determining Potash: T. E. Keitt.

In the official method there are two sources of error, one the diminished volume due to precipitation of the iron, alumina and tri-calcium phosphate when ammonia and ammonium oxalate are added to the solution after boiling; the second due to occlusion of potash by the above precipitate.

An Odd Result in the Chemical Analysis of a Potable Water: F. P. Dunnington.

Analysis of the water from a newly bored well showed astonishingly high amounts of nitrates, nitrites and chlorides, even after the well had been pumped dry twice. A full explanation lies in the circumstance that the party boring the well wound up by exploding a charge of dynamite "to open up crevices for water" and then to ensure a good job, put some salt in the well. In cleaning out wells some people complete the work by putting salt or lime into the well—an ill-advised custom, frequently encountered in certain regions.

In addition to the above papers there were two informal talks: one by Dr. C. L. Parsons on the radium situation and the capabilities of radium in the cure of cancer, the second by Dr. R. K. Duncan, who described the general organization of the scheme of fellowships in industrial research and recounted a number of the problems upon which the men working under this scheme are engaged; both of these talks were very interesting, and impressed those who heard them.

John Johnston,
Secretary of Section C

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION F—ZOOLOGY

Section F—Zoology—of the American Association for the Advancement of Science held its convocation week meeting in the histological building of the Atlanta Medical College, Atlanta, Ga., December 29 and 30, 1913.

Professor Frank R. Lillie, of the University of Chicago, was elected vice-president and chairman of the section for the ensuing year. C. C. Nutting, Iowa University, was chosen member of the General Committee of the association; Herbert Osborn, Ohio State University, was elected a member of the sectional committee (for 5 years), and E. W. Gudger, Normal College of North Carolina, was made a member of the council of the association.

The following papers were presented at the meeting, either in full or by title:

The Behavior of Leeches with Especial Reference to its Modifiability: Wilson Gee.

The first section of the work reviewed in this paper deals with the reactions of leeches to various classes of stimuli, such as light, chemicals, contact, currents, etc. The second section is an attempt to present, so far as possible, a causal explanation of the modified behavior described in the nephelid leech, *Dina microstoma* Moore. The different responses to the same stimulus were shown in their essential features to be in accord with our knowledge of reflex-arc structure and what might be expected of its conductivity in the various stages of excitement of the leech. Acclimatization to slight stimuli, such as shadows and shocks, was explained on the basis of the dulled sensibility of the receptors and slight changes in the nerve centers involved. It was shown that the phenomenon of fatigue in the leech possesses the same fundamental characteristics as fatigue in skeletal muscle. An important factor in explaining the behavior of the leech at a given moment was shown to be the consideration of the concurrent stimuli operative at that moment. Perhaps intermediate metabolic products are the cause of much of the difference in responsiveness between normal and well-fed leeches. The increased irritability of starved leeches is probably due to much the same cause.

Additional Data on Some of Eisen's Species of Lumbricidæ: Frank Smith.

Eisen in 1874 published a list of *Lumbricidæ* from Niagara and from Mt. Lebanon, New England, in which he described four new species. One of them is the widely distributed and well-known *Helodrilus parvus*. The other three species have not been reported since. Eisen gave only brief descriptions of their external characters and their real status has been uncertain. The United States National Museum has specimens of each of these three species which were given by Eisen many years ago, and are accompanied by labels showing that they were part of the original collections on which the descriptions were based. They are in the collections of *Oligochæta* which have been turned over to the writer for study. Sections have

been made and some of the more important facts of their internal anatomy determined. With the permission of the Secretary of the Smithsonian Institution, I make known some of the results of this preliminary study. *Helodrilus tenuis* has paired sperm sacs in XI. and XII. only, and has no spermathecæ. It belongs to the *Bimastus* section of the genus and is the same as *H. constrictus* (Rosa), described in 1884. Its relation to *H. norvegicus* (Eisen) is as yet uncertain. *H. tumidus* has sperm sacs in XI. and XII. only, and has no spermathecæ and hence belongs to the *Bimastus* section of the genus as has been assumed by Michaelsen. *Tetragonura pupa*, now regarded by Michaelsen as simply a form of *Helodrilus tetrædrus* (Savigny), is represented in the collection by a single specimen which, although labeled by Eisen as *Tetragonura pupa*, has spermiducal pores on XI. instead of on XII., as described by him. All of the reproductive organs and the crop and gizzard are four somites anterior to the position normal for Lumbricidæ. There is but one pair of "hearts" and they are in VII. The entire anatomy of this specimen is that which might be expected if a specimen of *Helodrilus tetrædrus hercynia* (Michaelsen) had lost the anterior nine somites and regenerated the usual number of five new ones. We do not know how many specimens Eisen may have had and it is certainly unsafe to assume that his description was based on this particular specimen. The real status of this species seems as uncertain as before. (These results will appear later under a different title in a more extended paper from the United States National Museum.)

A Study in Strongyloid Parasites of Cattle and Sheep in South Carolina: A. F. CONRADI.

Among the nematode parasites occurring in the digestive tracts of young cattle and sheep in South Carolina, the stomach worm, *Hæmonchus contortus* and the hookworm of cattle, *Monodontus phlebotomus* are very important. An extended study of these parasites was made covering a period of several years. The stomach worm occurs in both young cattle and sheep in injurious numbers. Hookworm has not been found injurious in sheep, but among cattle this is a species to be reckoned with. The life history of the two species is very similar. The eggs are laid in the stomach and after passing from the animal hatch in from three days to several weeks, depending on the temperature. In our work the stomach worm was almost altogether confined to the fourth stomach, while the hookworm was confined to the upper eight feet of the intestines. While the hookworm fastens itself to the intestinal wall and sucks blood, we were unable to prove this in case of the stomach worm. These occur in the mucous secretion between the mucous membrane of the stomach and the ingesta and are very rarely attached. Even when the specimen is attached it is but feebly so and can be removed, while in the case of the hookworm often the head is torn off when trying to remove it with the forceps. A vulnerable point in the control of both species lies in the fact that moisture is absolutely necessary for the egg and young larval development. This is true in the laboratory, and experiments in the field have shown that this point can be taken advantage of. A heavily infested lot being about one half creek bottom and one half hillside was divided so as to separate the lowlands from the highlands. An equal number of calves of the same age were placed on these lots in the early spring and these animals received the same amount and kind of feed, except that those in the lower lot obtained their water from a running brook. At the end of the season we had 62½ per cent. more calves on the upland than on the lowland. The following year all calves were kept on the upland and no death occurred. In our work the heaviest egg record occurs during June and July, while the death rate begins the latter part of August and continues through September and October. In our work no young calves born after August 25 took the disease, while the parasites left infested animals at from ten to fourteen months of age.

On the Whale Shark, Rhineodon typus: F. W. GUDGER.

The Eruption of the Permanent Teeth: ROBERT BENNETT BEAN.

Data for 2,221 school children. The eruption of the permanent teeth in the Filipinos is from one to four years earlier than in the Germans and Americans; females are more precocious than the males in all three groups. The lower permanent teeth erupt before the upper ones, except that the upper premolars erupt before the lower.

The teeth erupt in the following order: (1) Lower first molars; (2) lower median incisors; (3) upper first molars; (4) upper median incisors; (5) lower lateral incisors; (6) upper lateral incisors; (7) upper median premolars; (8) lower canines; (9) lower median premolars; (10) upper lateral premolars; (11) upper canines; (12)

lower lateral premolars; (13) lower second molars; (14) upper second molars; (15) lower third molars; (16) upper third molars.

The law of eruption is as follows: There are one or more periods of acceleration alternating with periods of retardation in the development of any one of the structures of the body. The periods of acceleration in the development of one structure may be synchronous with the periods of retardation in the development of another structure. Thus the period of the first six months after birth is one of rapid growth of the body in length, and this is followed by a period of comparative rest of the body while the eruption of the temporary teeth is taking place, all of which are through the gums by the end of the third year. This activity in dental growth is followed by a period of rest. Following this there is a second period of rapid growth in stature, subsequent to which the permanent teeth begin to erupt, after which the growth of the body is again accelerated, to be followed by a second rapid eruption of the permanent teeth and then another rapid growth of the body which is succeeded by puberty. The temporary teeth of the Americans are worse than those of the Filipinos which are worse than those of the Germans. The girls have worse teeth than the boys in all groups. The eruption of the teeth is one of the most exact means of determining the relative development of the individual and may be used as a physiological standard to determine the relative development.

Some Curious Parasites, Commensals, etc., Found on Alcyonaria: C. C. Nutting.

1. Discussion of the meaning of terms used to indicate the associations of animals discussed in the paper, and the analogies found in the *Alcyonaria* to plants.

2. Commensals found on *Alcyonaria*. (*a*) Those which are apparently harmless and do not modify the structure of the hosts. Illustrated by basket-fish, serpent stars and mollusks. Similarity in colors to the hosts. Possible advantage of association to commensals. (*b*) Those which directly modify the structure of the host, but do not subsist upon its tissues. A genus (*Calypterinus*) founded on such modification. *Stenella helminthophora*, in which the scale-like spicules have been remarkably modified to form a refuge for an annelid. *Calyptrophora ijimæ*, in which a web-like membrane including numerous spicules is formed by an annelid. *Echinogorgia pseudosassapo*, in which a barnacle has produced gall-like swellings in which it finds protection. *Solenocaulon*, in which it is claimed the leaves are modified to form arcade-like retreats for a macrouran crustacean, and, in another case, a brachyuran. (*c*) True parasites, apparently subsisting in part or in whole on the tissues of the host. *Chrysogorgia arborescens* with polyp bodies enormously enlarged by a parasitic crustacean of degraded type. *Suberia excavata*, in which the axis cylinder is extensively tunneled by a bivalve, and in which a degenerate annelid has also been found. (*d*) Parasites which do not live upon the tissues of the host, but which destroy it by strangulation. Millipores entirely covering an alcyonarian colony. Colonial anemones entirely covering a colony of *Caligorgia gilberti*.

An Experimental Comparative Study of the Behavior of the Animals of Two Aquatic Animal Communities: Victor E. Shelford.

The rapids and pool communities have been compared. The rapids community is characterized as *positive* to *strong current* and *negative* to *sand bottom*, while reaction to light, contact and gravitation are in accord with the position in which the animals live, *i. e.*, whether *on*, *under* or *among* stones. The pool community is *positive* to sand bottom, but only in part positive to current. It differs from the pool community in reactions to all the factors used. Those animals that are positive to current have a different optimum, hence animal communities differ in their behavior reactions.

Are the Preotic Myotomes of the Vertebrate Head Postotic in Origin? H. V. Neal.

The assumption of an exogenous origin of the otic region by Fürbringer ('98) and for both postotic and preotic regions by McMurrich ('12)—appears untenable in the light of the evidence. As pointed out by Johnston ('05) Fürbringer's inferences appear fallacious as a result of his failure to appreciate the relations of the nerve components in the occipital region. The main support for McMurrich's conclusions is therefore rendered doubtful. While the relations of the posterior rectus muscle of the eye to a postotic nerve—the abducens—might appear to favor the postotic derivation of that muscle, the relations of the remaining eye-muscles to nerves having preotic niduli do not support this opinion. Moreover, if McMurrich's assumption were true, it would appear necessary to assume the migration of somatic motor niduli from postotic into a preotic position and the associated migration of the mandibular and hyoid arches with which the myo-

tomes of the eye muscles are connected. The discovery of Van Wijhe's ('82) somites in Cyclostomes (Koltzoff '02) and of a similar mesodermic segmentation in the preotic region of bony fishes (Boecke '04) and of reptiles (Filatoff '07) taken in conjunction with the evidence of their presence in Amphibia (Miss Platt '97) and the repeated confirmation of their existence in Selachian embryos by Hoffmann ('94), Neal ('96, '97), Sewertzoff ('98) and Johnston ('09) attests not only the presence of a primary preotic segmentation, but also indicates that the mesodermic segmentation, as in *Amphioxus*, is continuous from the preoral region backwards through head and trunk. The recent rehabilitation of *Amphioxus* by Delsman ('13) as a transition form between annelids and vertebrates is symptomatic of the recent trend of morphological opinion. A fuller discussion of the problem will be given in a forthcoming number of *The Journal of Morphology*.

The Story of Human Lineage (vice-presidential address): WILLIAM A. LOCY.

Microscopic Demonstration of Fecal Contamination of Food, as Evidenced by the Presence of Protozoan Spores: C. W. STILES.

Instruction of Young People in Respect to Sex: T. W. GALLOWAY.

In a brief discussion like this some things must be assumed. Among these things we may mention the following: (1) Reproduction and sex, next to hunger and the need of food, is the most profoundly influential factor in human life. It is basal to society and to particular organization of society. (2) Anything which bulks as large in human life as sex can not be unimportant in education. (3) Its greatest meaning in education is not in connection with its abuses, perversions and dangers, but rather in the normal, wholesome and constructive contribution which it makes to health,—physical, mental, social, moral and religious. (4) Consequently sex instruction means not emphasis of the pathology of sex, but of the normal development of human personality and society because of, and by means of, the impulses growing out of sex. It deals with cleanness, purity, marriage, home, fatherhood, motherhood, children, parental care, chivalry and the like. (5) In the normal human child there is no such thing as ignorance and innocence with respect to matters of sex. The only choice we have is whether the information will be clean and correct and free from vile and vulgar connotations, or will be incomplete, suggestive and curiosity-inspiring. (6) Even if we could keep children ignorant, there is in the long run no positive correlation between ignorance in respect to vital and far-reaching phenomena and safe, wise adjustment to these phenomena. There *is*, however, a correlation between knowledge and right conduct, howbeit the correlation is not 100 per cent. (7) We must, therefore, have from some source, adequate instruction in respect to matters of sex. (8) We all agree that their instruction ought to come from parents and others similarly related to the child. (9) We know, however, that this is not being done by the present generation of parents in any serious degree. We know, furthermore, that the present-day parent is not fitted to do it properly. (10) We need, therefore, to prepare a generation of parents who can do this work for society. This must be done by social agencies outside the family. (11) Colleges and normal schools are in position to do two things for the people coming to them: (*a*) They may give the kind of instruction which parents ought to have; and (*b*) they may train future teachers in a fundamental knowledge of these matters so that they may bring help to the present-day generation of parents—through parent-teacher associations in the interest of the child.

The discussion of Professor Galloway's paper was led by Professor E. B. Wilson, of Columbia University, and was participated in by several members of Section F.

Variation in Oxyurias: Its Bearing on the Value of a "Nematode Formula": STANLEY B. FRACKER.

Owing to the difficulty of classifying Nematoda certain writers have used a "nematode formula" in their descriptions. This formula shows the proportions of the body structures of the individual worm described. The investigation which this paper reported consisted of the measurement of a large number of individuals of *Oxyurias vermicularis* Linn. to determine the variation in the species. The range proved sufficiently great to throw doubt upon the value of a formula. The conclusion was reached that while the general proportions of the organs of a round worm have a taxonomic importance, the formula as it has been used is likely to be more misleading than valuable. The full paper is to be published soon.

The Development of the Olfactory Nerve and Its Associated Ganglion in Lepidosteus: CHAS. BROOKOVER.

The olfactory nerve and the nervus terminalis

has been followed in its developmental history in a graded series of embryos and larval fishes to the adult condition. The olfactory nerve and the nervus terminalis are interpreted as arising together from the ectodermal nasal placode in the same way as was previously found in *Amia* and *Ameiurus*. The ganglion of the nervus terminalis can not be recognized with certainty until a late embryological stage (about 100 hours from fertilization) and later is divided into a compact central ganglion and a more diffuse peripheral ganglion in or near the nasal capsule. In the adult fish the central ganglion is located on the ventral side of the olfactory nerve anterior to the masticating muscles about an inch rostral of the brain. It can not be positively stated that there is fibrous connection with the other cranial nerves, but a large ramus of the fifth nerve runs in the same bony channel. We have recently found more than two hundred large ganglion cells associated with the olfactory fila in adult man that have been interpreted as belonging to the nervus terminalis. Full paper to be published in *Journal of Comparative Neurology and Psychology.*

The Library of Congress as an Aid to Scientific Research: E. W. Gudger.

The Library of Congress, the national library in fact if not in name, contains about 2,000,000 books, including the priceless Smithsonian Collection, and is the richest depository of the kind in the new world. These books, including sets of scientific periodicals and proceedings of learned societies, are, under very liberal regulations and restrictions, available for the use of those doing serious scientific research work anywhere in the United States. Further, the library maintains a division of bibliography the services of which are available to the research worker for the settling of bibliographical questions, for perfecting incomplete references, for compiling lists of references, and even for copying out brief extracts. On the other hand, to the scientific man, visiting Washington for the purpose of making use of the Library of Congress, every facility for work is accorded upon the presentation of proper credentials. He is given a room or an alcove in which to work, may even be admitted to the stacks, and if necessary may have an attendant or stenographer, while there is no limit to the number of books he may have on his table for reference. In short, it is the purpose of the librarian of congress and his associates to supply the unusual book for the unusual need, to make the national library the greatest reference library in America, and the speaker, having during the past seven years borrowed hundreds of books from it, is able to testify that this purpose is not a matter of theoretical intention, but of actual achievement. This being the nearest large library to the South, it has seemed well, at a meeting of the American Association for the Advancement of Science, held in a southern city and attended largely by southern men, to call the attention of Section F and of the whole association to the great function of this great library.

A Demonstration of the Ears of Some White and Colored People of New Orleans, La.: Robert Bennett Bean.

During the past three years and more I have collected about 200 ears of colored people in New Orleans, and about as many more of white people, some of which are preserved at the Smithsonian Institution, and the remainder at Tulane University. I measured the ears after classifying them according to my grouping of hyper, meso and hypo forms, but I found that many of the ears of the colored people were unlike any of the three forms, and I call them negroid ears. I had previously collected the ears of Filipinos and placed them in the Smithsonian Institution, and in addition to the ears that I have collected and measured I have examined thousands of ears of Filipinos, Negroes, white people and others, therefore, I feel qualified to classify the normal ear. The ears of the white people may be grouped into three forms which will be described briefly as follows: The hypo ear is a small round ear, that has a deep concha, with a raised helix, that makes the ear look like a shallow bowl. The meso ear is large, often almost rectilinear, and somewhat flattened, and not so bowl shaped as the hypo ear. The hyper ear is long, narrow and usually small, with everted tragus, antitragus and anthelix and rolled back helix. The meso ear seems to be the form from which the others have been derived, and the hypo and hyper forms have apparently undergone a greater amount of retrograde metamorphosis than the meso ear. The three forms are found among the colored people in almost as great purity as among the white people, but the most usual condition of either form is to present a certain amount of wrinkling of the helix as if it had been shriveled, and in contracting the ear is distorted. The ear of the Negro also appears in the form described by Hrdlička, which is small, almost square and flat against the head. The ears of the colored people are, as a rule, smaller than those of the

white people, and this in connection with the wrinkled condition and the presence of the ear described by Hrdlička has led me to consider the Negro ear as having undergone a greater amount of retrograde metamorphosis than the ear of the white people, even a greater amount than the hypo or hyper forms. I am at present at work on the development of the ear of the fetus in the colored people to determine the extent of development of the ear in the early stages of fetal development in order to find the extent of retrograde metamorphosis.

The First-year Zoology Course: John P. Campbell.

The first-year zoology course is of special importance, for the reason that most students go no farther. It should, therefore, have the widest human interest possible, and be no more technical than is necessary, in order to give the largest returns to the greatest number. As usually conducted, this course consists of a more or less intensive study of a few types, the idea being that the benefit to be derived is directly proportional to the amount of contact with these in the laboratory. This is believed to be wrong, and the idea is urged that the amount of laboratory time should be just enough to develop a mental attitude in the student, and put him in sympathy with the methods by which the subject has been developed. If the laboratory work consists merely in verification, no amount will do this, but if it is properly conducted, this result may be reached in less time than is commonly used. Emphasis should be laid also on the historical and philosophical aspects of the subject, and for this purpose students should be required to do wide reading and make ample abstracts. Every effort should be made to have the student get a large view of nature, and he should be able to interpret as well as observe. General discussions should be introduced wherever possible. Zoology is the study of animal life, and the more contact with life is presented, the stronger is the course. Morphology in the old sense has passed away, but the more the student learns to interpret structure in terms of modification in relation to environment, the more is he likely to be mentally awakened. The order of presentation is most important and, in the writer's experience, few students are intelligently interested in the Protozoa, if they are used to introduce the course. Insects serve much better as an introductory subject, after which evolution may be taken up. If then the Insects are reviewed and the remaining Arthropods taken up in the light of evolution, the study of the tissues in these leads logically into the Protozoa, after which the remaining phyla may be taken up in ascending order. The success of this course should be measured by the reaction of the student, and the proportion that are attracted to take the more advanced work, in which, of course, different methods should be pursued. The round-table discussion of Professor Campbell's paper was led by Professor Galloway.

The Content of a First Course in Zoology: T. W. Galloway.

I. This is so conditioned by what we desire to accomplish that I want to outline briefly some of the more important things I think we should try to do for the pupil in such a course. (1) We should produce and conserve a vital interest in animals. (2) We should secure an appreciation of the human values of animals. (3) We should encourage the attitude in the student of raising and solving problems concerning animals. This means the scientific attitude and the scientific method. (4) The pupil should have some ability to use the library, the field and the laboratory in pursuit of these interests. (5) He should be able to sustain interest in such problems for considerable periods. (6) There should be some sense of the way in which organisms respond to the environing conditions; some conception of individual development, and of the evolutionary series of animals. (7) The pupil should have some knowledge of the cell and of protoplasm as basal in plant and animal life. (8) He should get some practical experience in classifying organisms. (9) He should have a conception of the place of man in the biological series, and in such a way that it will heighten rather than diminish his appreciation of the meaning of the higher human qualities. (10) We should secure for him a sane appreciation of the origin and meaning of reproduction and sex, and of its bearing on human life.

II. It follows from the above that the point of view can not be narrowly morphological. Such, or all, of the possible approaches must be used as will contribute to these ends. Morphology, physiology, ecology and distribution, classification, touches of embryology and such general questions as evolution, heredity, history of biology and the like, must be included. Morphology alone secures little more than a certain deftness of observation and expression. Only when it is enriched by the more vital aspects do we secure discrimination, and the making and testing of general conclusions. The

pupil is entitled to "follow thru" in his mental processes.

III. Life is too short for these results to be accomplished by the laboratory alone or chiefly. The value of laboratory work is not in the zoological information gained by means of it. Its chief value is to enable the pupil to appreciate how the information got into the books, to give him skill in working out things for himself, and to use the increased interest he has in handling objects rather than in reading descriptions of them. It appears to me that about one half the time should be given to laboratory and field work, with more emphasis on the latter than is usual, and one half to class room, library and museum. I conceive that very much more use should be made of the library and somewhat less than is customary of the text or the lecture.

IV. I suggest the following for guidance in the selection of forms to be used in the laboratory study. They should be from those groups that have most human meaning; that are most common in the environment of the pupil; that have fewest disagreeable and repelling points; that illustrate best the great underlying processes and relations which we desire the pupil to get. Such a course might very appropriately emphasize the Protozoa, the Worms, the Mollusks, the Arthropods and the Vertebrates, in the laboratory and the field. The library and the museum may very well supply such synoptic view of the other groups as is needed in the first course.

It is quite difficult but quite important to remember that we are concerned to develop human beings and not in a mere logical display of zoological material. There is no necessary correlation between the two processes.

Note on the Present Status of the Gipsy Moth Parasites in New England: L. O. Howard.

Some Notes Regarding the Natural History of the Mole Cricket: E. L. Worsham.

The Jassidæ of Maine and their Bearing on the Distribution of this Group in America: Herbert Osborn.

Collections during the summer of 1913 greatly extend the records of the species in this family for Maine. For the most part these simply extend known range from adjacent localities, but in some cases from such distant points as Michigan, Iowa and even the Rocky Mountain region.

H. V. Neal,
Secretary

Tufts College, Mass.

SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

A regular meeting of the Physical Society was held at Columbia University, New York, on February 28, when the program was as follows:

"Radiation Constants of a Nitrogen-filled Tungsten Lamp," by W. W. Coblentz.

"The Villari Critical Point in Ferromagnetic Substances," by S. R. Williams.

"Motion of a Radiating Oscillator," by E. B. Wilson.

"A Method of Rapidly Extracting, Purifying and Compressing Radium Emanation," by William Duane.

"On the Asymmetric Distribution of Velocities of Photo-electrons from Platinum Cathode Films," by Otto Stuhlmann, Jr.

"On the Density of Radiant Action," by William Duane.

"Secondary Electron Emissions from a Hot Cathode Caused by Positive Ion Bombardment," by Irving Langmuir.

A. D. Cole,
Secretary

THE AMERICAN PSYCHOLOGICAL SOCIETY

The New York Branch of the American Psychological Association met in conjunction with the Section of Anthropology and Psychology of the New York Academy of Sciences, at Princeton, on February 23. The program was as follows:

"Some Tests of Efficiency in Telephone Operators," by Dr. H. C. McComas.

"Transfer and Inference in the Substitution Test," by Professor H. A. Ruger.

"A Comparison of the Effects of Strychnine and Caffeine on Mental and Motor Efficiency," by Dr. A. T. Poffenberger.

"A Comparison of Stylus and Key in the Tapping Test," by Dr. H. L. Hollingworth.

Inspection of the Psychological Laboratory of Princeton, and informal reports of work in progress.

"An Experimental Critique of the Binet-Simon Scale," by Carl C. Brigham.

"The Work Curve for Short Periods of Intense Application," by Professor R. S. Woodworth.

"Recall in Relation to Retention," by Dr. Garry C. Myers.

H. L. Hollingworth,
Secretary

SCIENCE

FRIDAY, MARCH 13, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN SOCIETY OF NATURALISTS SYMPOSIUM ON THE SCOPE OF BIOLOGICAL TEACHING IN RELATION TO NEW FIELDS OF DISCOVERY

FROM THE STANDPOINT OF A ZOOLOGIST

THE speaker must admit that upon taking time to reflect on the various ramifications of the subject announced his first reaction was one of wonder at himself for ever having agreed to enter into such a discussion; for obviously any statement must be the expression of a personal opinion influenced largely by the advocate's own training and the conditions which obtain in his local institution.

Upon roll-call one finds oneself confronted by such lusty newcomers as: ecology, animal behavior, comparative and general physiology, biochemistry, cytology, genetics, biometry, which, however, is really a method of work and not a special field of investigation; experimental zoology, a sort of general mélange which also includes some of the more special fields enumerated; experimental embryology, a subject inextricably interwoven with experimental cytology and which in recent times has sported a new offshoot—tissue-culture in vitro—already almost an ology in itself; not to omit such important applied subjects as parasitology, protozoology and the application of biological principles to human problems.

How much are we justified in letting these replace our traditional general zoology, invertebrate zoology, comparative anatomy of the vertebrates, histology and embryology? One realizes vividly the just merits of the new claimants, but when he faces the problem of deciding as to which

of the older subjects they shall supplant, he can not but hesitate. Which of these true and tried teething-rings of our zoological infancy shall be discarded? Can we spare any of them? I must confess that after considerable pondering I have concluded that for the training of the professional zoologist or the teacher of zoology I do not see how we can. I can find ways for shortening them to make room for new subjects and ways for injecting new meanings into them from our late fields of discovery, but it seems to me that when all is said and done, comparative morphology, including embryology, together with some histology, is a well-nigh indispensable ballast for our ship of biological progress. None of the newer experimental lines can yet take the place of these for training the zoological apprentice. I have yet to find the subjects in which I can pin my students down to exact observations, unequivocal inference and far-reaching generalizations in the concentrated form I can secure in a course of study based on morphology, but saturated throughout with demands for interpretation of the structures under consideration in terms of function and environment.

It seems to me, moreover, that nearly all of these newer lines actually or tacitly presuppose a considerable amount of systematic or morphological training. Much of our experimental zoology has bearings on the problems of evolution; hence what can such work mean to a student who has not reached an understanding of organic evolution from a careful comparative study of animals of different degrees of complexity? Or of what avail are many of the efforts of our statistical friends, the biometricians, without a keen appreciation on our part of the questions at issue, based fundamentally on an understanding of the real significance of variations? Or in the realm of animal behavior, one of the insistent new claimants for attention, the facts have meaning mainly as interpreted from the comparative or the evolutionary point of view, which presupposes knowledge of the relative complexities of the fundamental types of nervous systems. Of what significance, for example, is Professor Jennings's trained starfish, except as understood in terms of our knowledge of the starfish nervous system and the animal's relative position in the animal kingdom?

Or, taking the field of experimental embryology, how far should we get in true scientific appreciation of the recent work on tissue culture in vitro had we not considerable preliminary familiarity, not only with the structural nature of tissues but with general embryology as well? And when it comes to the quest for organ-forming substances, cytoplasmic prelocalizations or whatever we may be disposed to call precleavage differentiation, certainly the neophyte can travel the road towards understanding but a short distance without considerable preliminary knowledge of organogeny and even of cytology. Or again, in the field of genetics, while some of the practical values may be understood and utilized by those having meager knowledge of other biological facts, the full appreciation of the new discoveries can be grasped only by the well-rounded student, conversant with modern points of view in the fields of variation and evolution, embryology, cytology and general zoology.

Coming to cytology, no one, I think, will gainsay the statement that it is highly desirable for students to have had preliminary courses in comparative zoology, histology and embryology, to say nothing of a grasp of the problems of heredity and variation.

At the very outset of our planning, of course, we are met with the question, which of our students are we planning for? The five or ten per cent. who may become pro-

fessional zoologists, the somewhat larger proportion who are going into medicine, or the vastly greater proportion who are going to take only one, or, at most, two or three courses as part of their general education? Personally, after experimenting with various plans for different classes of students, I have reached the rather settled conviction that no matter what the later work of the students is to be, they may all profitably be subjected to the same first-year course; namely, a course which will give them a good perspective of the whole field of zoology, old and new, and which emphasizes general principles rather than morphological detail, though by no means ignoring the essentials of morphology, or in other words, a course arranged for principles and not primarily for types.

I think there is particular danger of the specialist letting his specialty obsess him to the disadvantage of his general introductory course. Even though facts are formally true in themselves, the student may be given an entirely erroneous view of the whole, if the facts emphasized are the less important components. To an entomologist all zoology may lie in the realm of the insect, or perhaps of even some particular group of insects; or, if a specialist in fungi, all botany centers, perhaps, in the toadstool and its anemic brethren; or if a cytologist, the student may hardly be led to realize that there may be something in the world of life worth studying that does not lie under a cover-slip. I thoroughly sympathize with the heartfelt cry that heads the title-page of a recent elementary text-book in botany, "More about hay, less about karyokinesis!"

The general course I have in mind, though omitting much of the technical detail that a professional zoologist must acquire, nevertheless should give the prospective specialist such an orientation in the whole field of his science as is almost indispensable for balance and which in all probability he will not get in any of his later courses. At the same time it must give the general student an intelligent insight into the real live problems of zoology and should tempt him to venture further into some of the special phases of the work which appeal to him. The laboratory work of this introductory course should, in my estimation, be a study of various animals in all their life relations, with a constant demand on the student for interpretation, not merely corroboration of anatomical and morphological descriptions. The forms should be selected to illustrate general principles of physiology, environmental relations, evolution and genetics as well as phylogenetic position. They should also introduce the student to the fields of embryology and histology. In our own university we have found a series consisting of the frog, ameba, paramecium, euglena, volvox, hydra, gonionemus, crayfish and bee to answer our purposes very well as an introduction to general principles in a one-semester course, although we prefer to have our students take a second semester of zoology supplementing the general work by additional forms taken partly from the same but mainly from other phyla of the animal kingdom.

The frog is admirably adapted to the elucidation of general principles of morphology, physiology and ecology, and also furnishes excellent material for an introduction to embryology and histology. In our own laboratory we devote a total of some fifty-six hours of work to the frog. We find it a decided advantage to begin with a form sufficiently large that every student can get to work on it during the first ten minutes of the first laboratory period. Having begun with a larger form, all will not come to the microscopical work

and require assistance at the same time. The transition from the histology of the frog to the amœba is a simple one, and in the succeeding series of forms we get not only more or less of a gradational morphological sequence which will give the student some idea of evolutionary progress, but a good series for the introduction of the ideas of animal behavior, differences between plants and animals and other fundamental problems. For instance, in volvox we see the beginnings of the body as distinct from the germ, and it affords a splendid opportunity for introducing ideas relative to germinal continuity, evolution of sex and the like. *Hydra* and *Gonionemus*, besides opening the way for the conception of metagenesis, illustrate the simpler principles of differentiation. The frog, crayfish and bee, when contrasted in their structural adjustments to environmental conditions, give an excellent selection for showing diverse means of meeting the same fundamental problems of existence. Lastly, the bee is excellent for guiding the student into the problems of genetics. I find that the single query in the laboratory outline as to how, inasmuch as the workers are sterile, their various characteristics are passed on to the next generation, is more serviceable in opening up to the student the real underlying problems of heredity than a considerable amount of mere lecture declamation on the subject would be.

From the first year on there will be a divergence among the students, depending upon their future intentions. Many will never get beyond the first course. On the part of general students, however, I find a strong and increasing demand for at least one or two additional courses which will afford them greater opportunity to get the bearings of biological principles on human problems. I think it can be justly urged, therefore, that this applied phase of the work is worthy of a modest course somewhere in the departmental curriculum after the first year. If "the true study of mankind is man," certainly the most promising approach to this study is through biology. Our social and educational problems have suffered too long already at the hands of the biologically untrained. I suspect that to the great majority of our students who will never become trained zoologists there is nothing of greater value we can give them than a clear-cut biological orientation towards the problems of human life. Train such students week by week and month by month in scientific discrimination and in the handling of biological evidence secured by their own efforts at observation, and we shall contribute to society fewer victims for the demagogue, the sensationalist and the charlatan.

Of all people, the prospective teacher and the social worker need the vivid knowledge of facts concerning living things that can be gained only by direct contact with the objects themselves, yet how few of either of this class ever get more than the colorless remnants of biological truth that may be gained at second hand through the paths of pedagogy and sociology! Many professors of pedagogy and sociology are coming to realize the importance of preliminary biological training for their protégés, and, although themselves biologically untrained, are endeavoring to make good the deficiency. While one sympathizes heartily with the feeling of necessity which prompts their endeavor, he can not but marvel at some of the biological rag-time effects not infrequently served up in these fields as biological truths.

How many teachers have an adequate understanding of the functional adjustments necessary to normal activities in either simple or complex animals? Yet, lacking this, how can they be expected to

prescribe for the imperfect mental or physical adjustments of their charges, to establish habits of thought or behavior, to correct defective habits by developing compensatory ones, or to lay down guiding principles for the most efficient furtherance of normal functions?

Or, to turn to the matter of natural endowment, how many of them realize that what a child becomes is determined in great measure by its inborn capacities and that education consists largely in applying the stimuli necessary to set going these potentialities and of affording opportunity for their expression? That of the good propensities some will require merely the start, others will need to be fostered and coaxed into permanence through the stereotyping effects of proper habits; that of the dangerous or bad, some must be kept dormant by preventing certain kinds of stimulation, others repressed by the cultivation of inhibitive tendencies, and yet others smothered or excluded by substituting in their place desirable traits? And yet if they are ignorant of all this are they not pretty much in the position of one who would attempt to operate a complicated engine without any understanding of its mechanism?

In this whole matter of human heredity, or eugenics, clearly the biologist is the one to lead the way, and yet we find this field being exploited by all sorts of impossible fanatics and incompetents. In spite of the badinage of the press and the confusion resulting from its use of the term eugenics in many senses, nearly all of them equally wrong, the science itself has come to stay, and the public, sensing the vital truth at bottom of it, is going to demand more and more enlightenment. Surely if anywhere we need here to guard against the ambitious enthusiast who promises the impossible, who, for instance, at one sword thrust would stay the demon of degeneracy and restore a sort of pristine purity to the human race. And yet how is the public to be guided aright unless biologists, the ones most competent to advise, step forward and keep them in touch with the more solid advances which are being made through the sure though unspectacular methods of research?

In our own institution I find a strong demand on the part of general students for at least an additional lecture course in genetics with emphasis on the eugenic phase. Some take the elementary embryology as a sort of laboratory course to accompany the work and it seems to me that this is a combination to be commended. I see no reason, moreover, why such students should not be encouraged to take, as many do with advantage, courses in ecology, animal behavior, elementary entomology or parasitology, according to their taste, even though they do not take the regular courses in invertebrate zoology or comparative anatomy which personally I feel are well-nigh indispensable to those who expect to teach zoology or become investigators.

But how, it may be urged, are we to find a place for the new subjects if we are still to retain our traditional courses? Will these not occupy quite all of the time that can be devoted to zoology?

One way to gain considerable time is to shorten some of these older subjects. This can be done without sacrifice of thoroughness on the part of the student, it seems to me, by dissecting fewer forms in detail and using the remaining forms largely for the study of the more significant features in which they are different. Why, for instance, have the student dissect out in minute detail the arterial system of the dog-fish, perch, necturus, turtle, pigeon and cat when a careful dissection of this system in the dog-fish, necturus and the cat, together

with a comparatively brief study of the corresponding systems in demonstration specimens of the other forms, will give him the necessary experience, knowledge and perspective to serve the full educative value of the work?

But does this advocacy of retaining the old standbys carry with it the corollary that they are to be taught in the same old way, from the same old malodorous specimens, and from the same old standpoint? By no means. There is such a thing as letting nearly all of the newer fields enter into the traditional courses to vitalize and illumine them while at the same time retaining their valuable disciplinary and informational features. We need not replace or dilute, but rather compress more of value into these courses by insisting on ecological and physiological along with the morphological and evolutionary interpretations. A frog, for example, is interesting enough as a piece of architecture, but it becomes many times more interesting when we advance to its interpretation as a machine constructed for the performance of a wide range of life activities. When the student examines our selected types of animal machines in the laboratory he should be made to realize that he is not only to interpret their respective structures as so many intergradients in an evolutionary series, but that he is also to explain the mechanism in each case in terms of function and adjustment to environment. What a given structure accomplishes and how it does it, what its efficiency is as compared with other types, is of fully as great importance as how, from the evolutionary point of view, this or that organ has advanced or regressed over the corresponding one in some other animal. Omit either kind of interpretation and the student has been deprived of valuable insight that he might have had with very little additional effort. It may seem banal even to call attention to this obvious fact, but visit the average laboratory or look into the laboratory manuals in common use and one can not but feel that this evident fact has been almost entirely ignored.

I think there is a nearly universal feeling to-day that we have been too closely wedded to structure and have wrongly divorced it from function and environmental adjustment; our convictions, however, find but tardy expression in our manuals and laboratory directions. Part of this situation is undoubtedly due to the inertia of routine. It is much easier to realize that another system is better than actively to break with traditional texts and guides and rearrange our work in harmony with our new ideals.

Supposing that I had a free hand to arrange a curriculum for a zoological department according to my own feeling of what would turn out a well-balanced student to undertake graduate work or to become a teacher in secondary work, I should plan about as follows: a two-semester course in elementary zoology of five credit hours per semester; a one-semester course each in invertebrate zoology, comparative organology of vertebrates, embryology and histology, omitting, if anything, the histology. Into all of these I would inject as much of the living animal and of experimental processes and interpretations as was at all practicable; that is, I would have these fundamental courses morphological but shot through and through with interpretations of functions and adjustments.

Finally I should want to see offered such additional courses in animal behavior, ecology, cytology, experimental embryology, general physiology, genetics and other special subjects, as the abilities and tastes of my departmental colleagues and myself would warrant.

As for graduate students it seems to me that since they are presumably mature individuals with thorough preliminary training in the main zoological subjects, one of the important things to do is to wean them away from mere course taking, a habit with which they are usually obsessed, and head them into problems and seminaries. If their preparation is inadequate let them take courses open to advanced undergraduates but strictly graduate courses can, I believe, be advantageously restricted to a few lectures per week in various special fields.

Being mature, the graduate student may well be expected to get much of his information by reading for himself. By way of suggestion I would give him a memorandum to the effect that it goes without saying that in addition to his more technical pursuits, every candidate for the doctorate will be expected to know modern evolution problems; the generally accepted views on phylogenetic relationships and the validity of the criteria on which these are based; and the elements of animal behavior, genetics and developmental mechanics. A suitable list of special references for study in these fields would be appended.

Furthermore, for the purpose of broadening his interests and cultivating a sense of proportion, each candidate might advantageously be given a list of fifty or more books that he is expected to have read before he completes his work. This list would include mainly the general classics of the subject in various departments, such as voyages, travels and explorations; history; biography; a few special memoirs; general principles; a few works of the better literary naturalists; and some of the more general works in special fields.

In conclusion I should say, then, that I see no need of abandoning our general zoology, comparative anatomy, invertebrate zoology, embryology and histology courses in favor of the newer biological sciences, though we can perhaps advantageously shorten them to make room for courses in the new subjects and we can pervade them all more or less with the method and thought of the newer work. If in these fundamental courses we will but put life back into our laboratory specimens, life into our method of offering them as subjects for thought, and life into our students by forcing them into the interpretative attitude of mind, then I think we shall have gone far toward introducing our charges to much that is significant in the newer fields without sacrificing the well-recognized values of the older discipline.

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FROM THE STANDPOINT OF A BOTANIST

THOSE of us who are possessed of a conservative temperament may be inclined to look askance at the newer fields of investigation, or to doubt their value for educational purposes. If so, we need merely to consider that not many years ago science of any kind was not regarded as a suitable subject for school or college. Moreover, the sciences themselves have undergone a marked evolution. The earliest biological studies were descriptive and enumerative; then came the study of internal structure, followed in its turn by the study of function, environment and inheritance. To an outsider it looks as though the subject of entomology were still largely in the taxonomic stage of development, which is not to be wondered at when one recalls that over half the species of animals are insects.

Instruction in biology has likewise exhibited an evolution; it no longer consists wholly or even largely of systematic work. Botanists still do a certain amount of "manual labor," but fortunately we have passed out of the period when first-year

botany consisted in a study of Gray's Manual, and the second-year botany of more Gray's Manual. Botanists have traveled a long way from the ideal of Linnæus, who declared that the only worthy task of a botanist is to know all the species of the vegetable kingdom by name. Thus progress has been the word in biological teaching, but, as has been the case in education in general, fads have crept in and have usurped the place rightly belonging to less spectacular but more fundamental aspects of the subject. One of the most pernicious of these in the recent history of botanical instruction is indicated by the flood of elementary text-books on so-called practical botany, in which there is very little botany, but a good deal of elementary forestry, horticulture, plant breeding and the like.

Since all of us specialists are faddists in a more or less worthy sense, we run the risk of introducing our favorite topics into our courses, and even giving them undue prominence. Moreover, we may experiment on the matter and method of our courses, while quite alive to the danger of riding our hobby in the lecture room. It will probably be agreed that the course which is most important from the standpoint of pedagogic experiment is the introductory course—general biology or general botany or general zoology, as the case may be. In fact it may be said that the crux of the question lies here, for if it can be decided what is to be the content of this general course the more advanced courses will readily fall into line; the character of the latter will be largely determined by the special needs in the particular institution; for instance, the course in plant pathology which would be required in a college of agriculture would naturally be represented in a less technical institution by an advanced course in fungi. Further, the general course includes all the biology which many students get, hence this course should be organized with particular care.

Coming then to the consideration of the general course, a study of curricula shows that there is a marked lack of unanimity among biologists as to what should be its content, and this fact causes no surprise, but is entirely reasonable in view of the diversity in needs of students. The lack of uniformity which courses exhibit arises from selection of material, for in a field so vast one can scarcely hope to treat the whole, even in a general way. If such should be attempted, we encounter at least two dangers: first, a topic must be treated so briefly that students fail to comprehend it. Any one who has tried to make Mendel's law clear to a freshman class will appreciate this statement. Second, when the student begins more advanced courses he loses the advantage of entering distinctly novel fields—we have already sucked the juice out of the orange, so to speak. But if the whole subject may not be covered, it becomes necessary to select, and continued selection through a period of time has resulted in the survival of the fittest, that is, the assembling of a number of topics which may be regarded as fundamental. These topics in a well-ordered course represent principles, for the plants or animals studied are not introduced for their own sake, but in order to illustrate one or more principles which it is desired to teach. Thus a liverwort may not be of great importance on its own account, but it illustrates alternation of generations and the probable origin of a land flora, and hence properly finds a place in a general course.

When a new field of discovery supplies facts which make a claim for introduction into the general course, they must justify the claim, lest we crowd out the tried and proved to make room for the new. The significance and value of a new fact may

be tested thus: how does it react on the already ascertained body of facts? Does it essentially modify what we have come to regard as fundamental concepts? The answer to these questions will go far in determining whether a new fact or theory shall find a place in a general course. Judged by this criterion, paleobotany has won for itself a place in any course where the relationships between plants constitutes one of the fundamental principles. Not that paleobotany needs to be introduced formally under that designation, but fossil plants may now be dealt with in an evolutionary scheme in the same way as existing ones, and our view of the plant kingdom as a whole is correspondingly broadened. To quote D. H. Scott: "Our whole conception of two at least of the great divisions of the Vegetable Kingdom—the Pteridophyta and the Gymnosperms—and of their mutual relations, is already profoundly influenced by the study of the ancient forms." In a similar way recent progress in plant anatomy has so far established a new point of view that its results must be incorporated in all but the most elementary presentation of the subject of morphology.

But there are other ways in which a new topic may justify its claim for insertion in a general course. The new facts may have such intrinsic and fundamental importance that they may fitly find place in a course. although not reacting to any considerable extent on the older material. In this way the leading facts concerning inheritance may justify the place they hold in some general courses. A real difficulty in including this topic arises from the fact that freshmen lack the antecedent training in cytology and embryology which is desirable before one can really grasp the principles of heredity.

A principle which must not be lost sight of in deciding for or against a new topic is its pedagogic value. New subjects suffer in this respect from their lack of organization; they consist largely of a number of interesting and significant observations, but these are at first unrelated, and therefore of inferior value for teaching purposes. A good example is seen in the mass of facts which is accumulating as the result of the activity of workers along Mendelian lines. It has also been noticed that speculation has run far in advance of these facts—an observation which carries its own moral. Plant ecology is another branch of the subject which lacks organization. As Cowles has said, until recently ecology had no fundamental concepts. Moreover some of the workers who have rushed into this field have not hesitated to provide a plausible explanation for every phenomenon, with the result that careful work has been discredited along with the hasty. We should beware of the attitude of mind which leads us to explain everything. We have abundant reason to consider this matter of pedagogic value, for we must realize that sciences and especially the biological sciences are still on trial as subjects suitable for schools and colleges, and that some disappointment has been manifested at the results following their introduction. All sciences still suffer from a lack of the definite organization which has long been possessed by the classics and mathematics. Biology is indulgently tolerated by the followers of the more exact sciences; in the words of one of my engineering colleagues, "biology is largely an observational subject." Hence we do well to be sparing in our introduction of new and unorganized branches of our subject. We are in danger of sacrificing a training in exact thinking, such as is provided by comparative morphology, and gaining only intellectual haziness. That this is a prevalent and serious defect in American education is

borne out by the report of Oxford tutors concerning Rhodes scholars; the tutors readily admit the mental alertness of the American scholars, but uniformly remark upon their inability to settle down to do a long spell of thorough work.

Again, since we very properly lay more stress on nature than on books, the availability of a new topic for laboratory purposes must be considered. It is a matter of common experience that morphological work presents fewer difficulties than any other when unwieldy classes have to be marshalled section after section in overcrowded laboratories. Unless numerous assistants and abundant laboratory and greenhouse space are available, work along physiological, ecological or genetic lines is apt to result in much waste of time and few profitable results, while at the same time the student is missing the opportunity of laying a stable morphological foundation for his later studies.

Even when the best word has been said in behalf of the newer fields, the preeminence of morphology as the *sine qua non* of instruction remains untouched. Though the educational pendulum may swing far to the right and left, it returns to its stable position, and that position points to morphology. One of the dangers which a student encounters is that of specializing too early, before he has laid a solid foundation. Hence our general course must show a preponderance of that branch which experience has shown to be fundamental. Examples of the fatal consequences of an absence of adequate knowledge of morphology are not hard to find. On the botanical side we need only recall the blunders of the earlier paleobotanists, who framed phylogenies based on external structures only, and in our own day we have the sorry spectacle of experimental morphologists who have a slender grasp of morphology, and of plant physiologists who propose theories which are at once seen to be untenable when viewed in the light of the elementary facts of histology. Work in genetics or in plant pathology carried on by those who are not rooted and grounded in morphology is bound to be of the empiric type, too greatly resembling the product of the short courses in agriculture.

What then shall be the nature of the well-ordered general course? Since a paper such as this is more or less the writer's confession of faith, I may as well conclude by telling what we are attempting to do in the institution which I represent. First, the course is one in general *biology*, in which the professors of botany and zoology lecture in turn, each completing a topic before giving place to the other. During the greater part of the year the morphology of the two kingdoms is developed, but each form selected for study is considered not on its own account, but is introduced in order to illustrate some fundamental principle. Form and function go hand in hand, each supplementing the other. Thus the course is strung on an evolutionary and also a physiological thread. Any form which does not fit in with this scheme is ruthlessly weeded out. At suitable times general topics such as evolution, heredity and certain ecological themes are formally treated. Laboratory work for the most part follows the order of topics adopted in the class-room, but while human physiology is being considered in the class-room the class is dissecting the frog in the laboratory.

Realizing that it is somewhat presumptuous for one man to speak for all botanists, I have sought the opinion of a botanist who has had long experience in teaching, Dr. John M. Coulter, and have been pleased to find that his view of the subject matter of an elementary course pretty closely cor-

responds with the one expressed in the foregoing. I take the liberty of quoting:

I should say that the elementary course or courses in botany should always be synthetic. Fundamental in the synthetic presentation of botany I should say is morphology, for I do not believe that any effective work can be done without some knowledge of the structures involved. Then I should say that the morphological thread that runs through the course should string together the most important physiological phenomena as explanations of morphological structure. In fact, I would not regard any morphology as significant that could not be explained in terms of physiology; and on the contrary, I would not regard any physiology as worth while that could not be fitted into morphological structure. In other words, I can not divorce the machine from its work. Naturally in this statement ecology becomes merely a form of physiology. This would be my general notion as to the content of an elementary course in botany.

What should be given afterwards depends entirely upon the size of the botanical staff and its differentiation in interest. After the synthetic course, I think there should be opportunity to develop morphology, physiology, ecology, etc., independently. Of course, experimental morphology should come in as a hybrid between morphology and physiology. I should say that genetics would come after almost everything else.

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EXPERIMENTALISM IN ZOOLOGY

THE followers of science have shown at all times a marked disposition to readjust the style of their intellectual apparel to new conditions, and in this respect the zoologist is no exception. There are some among us who still prefer to appear in the ancient and respectable mental garb of the systematist, others who adorn themselves in the Empire costume of the comparative anatomist, and still others who have put on the Victorian attire of the embryologist. But he who wishes to be truly modern is content to clothe himself in only the scanty raiment of the experimentalist. A glance at this last class shows it to be made up of the young and the would-be-young. This latest style, unlike its predecessors, is not a creation from Paris or from London, but is largely a home-product, the result of what its inceptors would call internal factors, those conveniently vague things about which we know so little. Although we are not wholly clear as to the process by which we have come to be experimentalists, we are convinced that it depended upon something like an irreversible reaction and that we have come to stay.

The experiment, however, is by no means a modern invention. As early as the thirteenth century Roger Bacon was proclaiming to unsympathetic scholars its soundness as an instrument for the discovery of truth. In his opus majus he maintains that

There are two modes of knowing; by argument and by experiment. Argument concludes a question; but it does not make us feel certain, or acquiesce in the contemplation of truth, except the truth be also found to be so by experience.

And still farther on in the same work he declares that

Experimental science, the sole mistress of speculative sciences, has three great prerogatives among other parts of knowledge: First, she tests by experiment the noblest conclusions of all other sciences; next, she discovers respecting the notions which other sciences deal with, magnificent truths to which these sciences themselves can by no means attain; her third dignity is, that she by her own power and without respect of other sciences, investigates the secrets of nature.

Although Roger Bacon's utterances in favor of experimental science were made over three centuries before the days of his illustrious fellow countryman, Francis Bacon, and at a time when such utterances were dangerous, they were by no means the earliest expression of the experiment. Some sixteen centuries before Roger Bacon's time, Aristotle wrote in simple language an account of what is probably the

earliest recorded biological experiment. It deals with the physiology of the senses and reads as follows:

> By crossing the fingers a single object under them appears to be two and yet we do not say there are two; for sight is more decisive than touch. If, however, touch were our only sense, our judgment would declare that the single object is two.

Thus Aristotle employed the experimental method for the discovery of truth. With all this history behind us it may seem strange that we have been so slow in appreciating the significance of this method. But it must be remembered that the biological sciences, unlike physics and chemistry, have had an enormous volume of descriptive material to handle, and that it was only after this task was well under way that really fundamental problems could be attacked. It is also to be kept in mind that such sciences as chemistry and physics have begun to yield only recently results and methods which have been of direct service to biology. Viewed from this standpoint the whole course of development of the methods employed in biological research is a natural one, and, though we may not fully appreciate all the steps by which we have reached this new road to discovery, we are persuaded that the course we have taken is the result of the untrammeled growth of our science.

With the acceptance of the experimental method as a part of the means of biological research comes the responsibility of training students in the new way of work. To those of us whose zoological apprenticeship centered round the paraffin bath and the microtome, this is no simple proposition. With little physics, less chemistry, and almost no mathematics we find ourselves poorly equipped to meet the new emergencies. One of my colleagues trained in this fashion seems never to appreciate the fact that there is a third dimension in space, and in my case mathematics is metamorphosed from one of the most exact forms of expression into one of the most inexact. Although we may take consolation in the fact that even so illustrious a physicist as Faraday was essentially unmathematical, we can not look upon the deficiencies that I have just pointed out without recognizing that they are real shortcomings. These defects in our early training can not be ascribed to lack of reasonable foresight on the part of our teachers or even to our own idleness. They are the natural result of the prodigious rate at which our science has been growing, a rate that made it impossible for even the best informed of a generation ago to predict the needs of today. This is true not only of the present, but also of the past. Darwin's early training was that of a physician, and Huxley actually went into medical practise. Both men in their early days never entered a biological laboratory, for the obvious reason that no such institution existed, and both regretted their educational deficiencies.

Inadequately trained ourselves, how are we to meet the problem of training others in the new directions? The situation seems to include to a certain degree the impossibility of lifting oneself by one's boot-straps. But I suggest that while tugging at the straps a slight jump will lift us a little, and the jump that seems to me to be advisable is to recommend that our students pay more attention to chemistry and physics, sciences in which the experimental method is well developed and which are yielding results that are applicable more and more to the fundamental problems of biology. Such a training, when rigorously pursued by a student with a clear understanding of its relations to biological work, is bound to be richly productive as soon as it is turned in the appropriate direction.

But physics and chemistry are, in my

opinion, only part of the preliminary scientific training for these new lines of work. The zoologist is continually confronted at least in his study of the higher animals with those complicated conditions that we recognize in our own mental states. That such conditions exist in varying degrees in the lower animals no one can deny. The questions that arise concerning them are what is their nature and to what extent are they present in the lower forms. These problems are psychological, and I should, therefore, regret to see a prospective zoologist omit from his preliminary training a reasonable grounding in this field of investigation. In one way, however, I regard psychology as less important for the beginner than physics and chemistry. In it the experimental method is less completely developed than in the two sciences just named. In truth, it is in this respect much like biology itself and in need of help especially from the side of chemistry. The genius of Helmholtz seems to have had such an overwhelming influence on most psychologists that they have been content to study almost exclusively the physics of sensory phenomena to the neglect of other psychological fields, such as the chemistry of the central nervous states. But though psychology may have its own difficulties, I nevertheless regard it as a field that should be included in the general training of every student who aspires to a broad-minded and productive scholarship in zoology. With the botanist it may be different. He sometimes counts himself fortunate to have escaped the problem of mind, but to my way of thinking this very problem is one of those elements which makes zoology so intensely interesting.

But the young zoologist trained in the experimental method by physics and chemistry, and heedful of the fact that the material of his investigation may exhibit among its characteristics some of the phenomena of intelligence, must still assume a very different attitude toward his work from that which most of us were accustomed to in the laboratories of twenty or thirty years ago. Those were the days of morphology, when the visible structure of the organism was all important and the problem of the homology of various parts, the integrity of the germ layers, and so forth were of foremost interest. The attitude of the average student of those days was essentially anatomical, and the anatomical conception of an organism was that of a standing motionless object. Immensely important as this view was, it lacked the really essential characteristic of the living thing, its incessant activity. The new view, on the other hand, includes just this feature. The student of thirty years ago was concerned with methods of preserving animals and he never felt safe until his catch was in the alcohol jar; the modern student is all alert to keep his stock alive and he consigns it to preservatives with funereal rites. This change in attitude is part and parcel of the new growth and is working a slow but steady revolution in the equipment of our laboratories.

With all this overturning and revolution going on in our advanced work, what can we say of our elementary instruction. Here we are supposed to keep to those aspects of the subject that are well established and that are not open to fundamental revision. Moreover, in this direction the procedure of lecture work and laboratory routine is well established in text-books and the like, and the instructor, in keeping in these well-worn paths, is on what seems to him to be safer grounds. But even the elementary courses, in my opinion, must not be devoid of promising outlook. They should include a reasonable amount of the new work. But to accomplish this without printed

guide or previous training is not an easy task for the older teacher. Here is perhaps the point in the new work at which the young and the would-be-young are most clearly differentiated. To me the contemplation of this subject is embarrassing and I pass it by. But for the encouragement of those who are in my plight, I must add a word from my own experience.

I believe that some of us who are older teachers fail to appreciate, from our disinclination to give the matter a trial, how easy it is to arrange elementary courses, especially the laboratory exercises in such courses so as to illustrate animal activities by the experimental method. I know that in my own experience a laboratory course which I gave to high-school teachers a year or so ago was in this respect immensely illuminating. I had no idea that the new methods could be applied so directly. To give some notion of the nature of the work that can be carried on in such courses let me name some of the exercises that we found serviceable: the effects of light on the movements of planarians, earthworms, mealworms and the larvæ and adults of flesh-flies; the combined influences of gravity and light on the movements of fruit-flies; the effects of odorous substances on the movements of earthworms and on the gathering of fruit-flies; the feeding reactions of planarians, catfishes and toads; the means of locomotion in earthworms, mealworms and snails; the reactions to stimulation in paramœcium, and its rate of reproduction; regeneration in planarians and earthworms; heredity in fruit-flies. These and other like exercises were found surprisingly applicable to elementary work and have encouraged me to believe that practise in experimental work may well be introduced into elementary courses.

Such work, moreover, is not without its beneficial influence on the teacher. No two animals are ever alike in their reactions, and in this respect they differ vastly more than they do in their structure. Although each exercise can be made to lead to a general conclusion for all students concerned, the details of the work soon come to be individual. The instructor is called upon, therefore, rather as an adviser in method than an authority in facts, and from this standpoint his attitude toward his work is much more natural than what it often is in purely anatomical exercises. Woe be to him if he begins to tell what a given animal at a given moment will do! I know of no elementary biological exercises that are better adapted than these to develop independence and originality in the student and to reduce the instructor to his true position, that of a student of greater maturity than those about him. As a result of this experience, I look with great hope on the steady introduction of experimental exercises into our elementary work. Certainly the conception of an animal that is gained from work such as this is much nearer the truth than that which we have been instilling through alcoholic specimens.

But if these are the realities of the experimental method, what are its vanities? I think the chief pitfall that besets the experimentalist is apparatus. What a strange allurement this feature of the situation has for us! What can be more pleasant to the eye than beautiful apparatus in glass cases or a grand array of delicate contrivances built up upon a table! And they are always so interesting to the visitor! But I shall never forget the comment of a friend of mine who on looking over an extensive device of my own construction finally remarked that the justification of such work as biological did require a goodly supply of brass. But if apparatus is our pitfall, we must remember that many of the pioneers in the new movement have

already demonstrated to us fundamental results by means as strikingly simple. To Loeb the problem of the universe is soluble in a finger-bowl; to Morgan in a milk-jar; and we must never forget that the importance of a result is often inversely proportional to the complication of the apparatus by which it was attained. With these examples before us, let us avoid the pitfall of bright glass and shining metal.

I have entitled this paper "Experimentalism in Zoology" and I have nowhere used the term experimental zoology. This has been intentional, for I do not believe in this term. The new movement does not mean a new province in zoology; it is a new method of attacking old problems. It will, of course, lead us to new fields, but it is method rather than matter. We are not exchanging old lamps for new but burning the old lamp in a new way. I therefore resist the term experimental zoology. We are all still zoologists and we have simply added to our equipment the experimental method. As each one, old or young, realizes the significance of this method and the great power that it puts in his hand, he will adopt it in proportion to his needs and abilities. In this way it is gradually pervading the whole fabric of biology from the realm of the systematist to that of the ultramodernist. Our times are full of such changes. To-day we men vote, to-morrow our women will vote. Let all such changes come as natural growths.

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THE PRODUCTION OF RADIUM, URANIUM AND VANADIUM ORES IN 1913

PROBABLY no other mineral is mined which has so large a hold on public attention and at the same time has so small a total monetary value as the uranium minerals. This interest is, of course, due not to the minerals as such, nor to the uranium they contain, but to the accompanying radium, which is found only with uranium. Hitherto the interest in radium, though lively, has been largely academic, on account of the marvelous qualities which it displays when compared with better-known elements. Toward the end of 1913, however, public interest became almost feverish, owing to the apparent cures of cancer wrought by the application of the gamma rays given off by radium.

Uranium minerals were produced in commercial quantity in the United States in 1913, as shown by preliminary statistics gathered by Frank L. Hess, of the United States Geological Survey, only in Colorado and Utah, and although during the year some pitchblende was mined in Colorado in the Belcher & Calhoun mines, only a few pounds were sold, though 50 dry tons of low-grade material carrying 1.49 per cent. uranium oxide (U_3O_8) was shipped to France from the Kirk mine. This had been mined a previous year. Carnotite, a yellow powdery or waxy mineral found in the sandstones of the high plateau between the Rocky Mountains of Colorado and the San Rafael Swell of Utah, south of the Book Cliffs, furnished the whole production.

Carnotite, as the word is ordinarily used, is a potash or lime uranium vanadate. Several vanadium minerals occur with the carnotite, so that in mining for uranium a great deal of vanadium is also obtained. At Newmire, San Miguel county, Colo., one of the vanadium minerals, roscoelite, occurs practically free from uranium and is worked for vanadium alone.

The total mine shipments of uranium and vanadium, as shown by preliminary figures, were equal to 2,140 tons of dry ore, carrying an equivalent of 38 tons of uranium oxide. The vanadium in carnotite ores shipped, together with that which is estimated to have been produced from the Newmire district, was equivalent to 914 tons of vanadium oxide. These quantities are equal to about 32.3 tons of metallic uranium and 412 tons of metallic vanadium.

The Bureau of Mines has determined that carnotite carries about 90 per cent. or even a little more of the theoretical quantity of radium in equilibrium with uranium, which, according to Rutherford ("Radioactive substances and their radiations," p. 16), is equal to about 1 gram in 3,000 kilograms of uranium. Assuming that 90 per cent. of the radium is recoverable, this would give 16.40 grams of hydrous radium bromide, worth, about $120 a milligram of metallic radium, about $1,055,000. The total value of the carnotite ores sold was about $142,000, which represents the uranium value only, as little was paid for the vanadium content and the figures for these receipts are not yet in hand.

The production of the year was the largest ever made, according to the Geological Survey figures, that for 1912 being equivalent to 26 short tons of uranium oxide (22 tons of the metal), and that for 1911 being equivalent to 25 tons of uranium oxide (21.2 tons of the metal)—an increase of nearly 50 per cent. for 1913.

Of the quantity produced, apparently 19.25 tons of uranium oxide, containing the equivalent of 8.3 grams of hydrous radium bromide, was shipped to Europe, and 18.75 tons, containing the equivalent of 8.1 grams of hydrous radium bromide, was retained in this country, although in tonnage the quantity retained in this country, 1,198 tons, was larger than that shipped to Europe, which was apparently 942 tons. One of the principal producers for foreign trade did little work for more than half a year, owing, it is reported, to the fact that its factory in Liverpool had not been completed. Had the factory come into operation sooner the exports would have been considerably larger.

A prominent feature of uranium and vanadium production during the year was the change in method of payment by American buyers, who no longer paid for the vanadium content in the ore but bought it on the basis of the uranium oxide content alone, though they received payment for the vanadium abroad. However, the miner received more or less compensation in a higher price for the uranium oxide he sold. Prices varied greatly and returns to the Survey show that the price per pound for contained uranium oxide ranged from $1 for ores carrying 0.6 per cent. uranium oxide to $4.60 for one lot carrying 3.15 per cent. uranium oxide and 4.82 per cent. vanadium oxide.

The demand for carnotite at increasing prices caused a large amount of prospecting, and the carnotite-bearing area was shown to extend from the Paradox country westward into the Dry Valley region of Utah, lying between Monticello and the La Sal Mountains. Farther west and south deposits of carnotite were found on Crescent and Trachyte creeks, in the Henry Mountains, and also southwest of the mountains.

During the fall a geologic reconnaissance of the uranium and vanadium deposits of Utah was made by Frank L. Hess and B. S. Butler, of the United States Geological Survey. They covered the territory lying between the Wyoming line and the south side of the Henry Mountains, and east of the San Rafael Swell. The deposits, as shown by the outcrops, are nearly all in small pockets, part of which are comparatively rich. All the newly found localities are far from railroad and the hope for commercial production from them lies in concentration on the ground by some cheap process, and many experiments are being carried on to develop such a process. Toward the end of the year steps were taken for the erection of a concentration plant in Dry Valley, 15 miles north of Monticello. A plant was put up on Mesa Creek, Colo., and another was said to be in course of erection in the Gateway district. A preliminary report on the uranium and vanadium deposits of Utah will probably be issued during the spring.

The Standard Chemical Company actively produced radium at its plant at Canonsburg, Pa., and the Radium Company of America established a plant and did preliminary work at Sellersville, Pa.

THE PREMEDICAL CONFERENCE

THE Cincinnati Conference of Academic Institutions and Medical Colleges on Premedical Education was held at the University of Cincinnati, January 16–17. The occasion marked the installation of Dr. Christian R. Holmes as dean of the Medical College. The inauguration address was given by Dr. Wm. H. Welch, of Baltimore, his subject being "The Development of Medical Education in America." Dr. Welch was later entertained at a banquet.

Representatives of many of the medical and academic institutions of the Middle West conferred on the requirements of premedical education with a view to bettering and standardizing the preparatory work. Among those who addressed the conference were Pres. Charles W. Dabney, Drs. Wm. H. Welch, Charles Dean Bevan, John A. Witherspoon, N. P. Colwell, Henry B. Ward, Michael F. Guyer, Lauder W. Jones, Brown Ayres, Edgar Brandon, Dean Christian R. Holmes, Paul G. Woolley, Harry Marshall and others. There were present the secretary, two ex-presidents and the president of the American Medical Association.

A committee consisting of Professors Michael F. Guyer (chairman), Harry N. Holmes, Lauder W. Jones, Henry McE. Knower and E. L. Rice drew up the following resolutions, which the conference adopted:

In view of the ideas expressed in this conference, be it

Resolved, That the representatives of the various colleges confer with their respective faculties to ascertain:

1. What courses of a premedical nature are offered by them in chemistry, physics, biology and languages.

2. What changes, if necessary, can be made to establish uniformity of essentials in premedical training.

3. Whether it is possible to reduce the total time now required to obtain the M.D. degree by eliminating duplication of work existing in graded schools, high schools, colleges and medical schools. Your committee is of the opinion that this is feasible.

4. What arrangements are made for granting the bachelor's degree after satisfactory completion of two or three years' college work and one or two years in a Class A plus medical school.

Be it further resolved, That the action taken by the various faculties be reported to Paul G. Woolley, University of Cincinnati, chairman of the general conference committee, and that this committee may, at its discretion, call another general conference of the colleges interested in this movement.

It was generally agreed that physics, biology, chemistry and modern languages have an unquestioned place in the premedical education. Reprints containing the discussion and addresses can be obtained on request from the university.

The delegates inspected the medical college laboratories and the new $4,000,000 city hospital, which Dr. Holmes is just bringing to completion. The plans for the new medical college building, on the hospital site, were exhibited.

THE AMERICAN CHEMICAL SOCIETY

THE forty-ninth meeting of the American Chemical Society will be held in Cincinnati, Ohio, from Tuesday, April 7 to Friday, April 10, inclusive. A meeting of the council will be held at the Hotel Sinton on Monday evening, April 6. The Hotel Sinton has been chosen as headquarters.

The general meetings and the meetings of divisions will be held at the University of Cincinnati.

The transportation committee has arranged a number of interesting visits to local industrial plants. It is a well-known fact that Cincinnati has a very large variety of industries which are strictly chemical or very closely allied. This committee has already arranged trips to the Filtration Plant, Proctor & Gamble's, the home of Crisco and Ivory Soap; Globe Soap Co., Diamalt Co., Andrew Steel Works, Boldt Glass Co., the New Cincinnati Hospital, the largest and most modern city hospital in the world; Machine Tool Plants, Rookwood Pottery, Lloyd Brothers, W. S. Merril Chemical Co., and many others.

In addition to these inspection trips the committee is planning to devote Friday, April 10, to visit adjacent industrial plants—an all day excursion. It is the plan during the morning

to go to Middletown and inspect the plant of the American Rolling Mills, the home of Ingot Iron. After visiting this plant the party goes to Dayton, where members of the Cincinnati Section, residents of Dayton, have arranged an inspection trip through the plant of the National Cash Register Co. Negotiations are now in progress to have Mr. Wright give an exhibition of his latest aeroplane, including the stabilizer.

The following provisional program will give an idea of the plans for the Cincinnati Meeting:

Monday, April 6, evening, council meeting.

Tuesday, April 7, morning, general meeting; afternoon, excursions; evening, smoker at zoo.

Wednesday, April 8, morning, division meetings; afternoon, excursions; evening, concert by the Cincinnati Symphony Orchestra at Emery Hall.

Thursday, April 9, morning, division meetings; afternoon, division meetings; evening, subscription dinner.

Friday, April 10, excursion to American Rolling Mills, Middletown, O., and the National Cash Register Company, Dayton, O.

Following are the addresses of the Divisional and Sectional Secretaries:

Divisions:

Agricultural and Food Chemistry: G. F. Mason, H. J. Heinz Company, Pittsburgh, Pa.

Biological Chemistry: I. K. Phelps, Bureau of Chemistry, Washington, D. C.

Fertilizer Chemistry: B. F. Carpenter, Virginia Carolina Chemical Co., Richmond, Va.

Industrial Chemists and Chemical Engineers: S. H. Salisbury, Jr., Lehigh University, South Bethlehem, Pa.

Organic Chemistry: C. G. Derick, Morris Ave., Lincoln Place, Urbana, Ill.

Pharmaceutical Chemistry: A. P. Sy, University of Buffalo, 24 High St., Buffalo, N. Y.

Physical and Inorganic Chemistry: R. C. Wells, U. S. Geological Survey, Washington, D. C.

Sections:

India Rubber Chemistry: Dorris Whipple, the Safety Insulated Wire and Cable Co., Bayonne, N. J.

Water, Sewage and Sanitation: Harry P. Corson, State Water Survey, Urbana, Illinois.

All Divisions of the Society will meet. The Water, Sewage and Sanitation Section has announced that it is planning a special conference on Standard Methods of Water Analysis. The Rubber Section hopes to have a large meeting, as Cincinnati is conveniently located to some of our largest rubber manufacturing centers.

SCIENTIFIC NOTES AND NEWS

The following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Dr. Edgar Johnston Allen, Mr. Richard Assheton, Mr. Geoffrey Thomas Bennett, Professor Rowland Harry Biffen, Dr. Arthur Edwin Boycott, Mr. Clive Cuthbertson, Dr. Henry Hallett Dale, Mr. Arthur Stanley Eddington, Professor Edmund Johnston Garwood, Mr. Thomas Henry Havelock, Dr. Thomas Martin Lowry, Professor Diarmid Noël Paton, Mr. Siegfried Ruhemann, Dr. Samuel Walter Johnson Smith and Dr. Thomas Edward Stanton.

The seventieth birthday of Professor A. Engler, the distinguished Berlin botanist, will be celebrated on March 27, when a marble bust will be presented to him.

Professor R. W. Wood, of the Johns Hopkins University, gave in London, on February 27, the first Guthrie lecture of the Physical Society, his subject being "Radiation of Gas Molecules Excited by Light."

Dr. George E. De Schweinitz, professor of ophthalmology in the University of Pennsylvania, was given by the university the degree of doctor of laws, at its recent university-day celebration.

Dr. E. W. Hobson, Sadlerian professor of pure mathematics at the University of Cambridge, has been nominated to represent the university on the occasion of the celebration on June 29–30 and July 1 of the three hundredth anniversary of the foundation of the University of Groningen.

Dr. A. Smith Woodward has been elected president of the Geological Society of London.

Officers of the Royal Astronomical Society have been elected as follows: *President*, Major E. H. Hills; *Vice-presidents*, Dr. F. W. Dyson,

Dr. J. W. L. Glaisher, Professor H. F. Newall and Professor H. H. Turner; *Treasurer*, Mr. E. B. Knobel; *Secretaries*, Professor A. S. Eddington and Professor A. Fowler; *Foreign Secretary*, Professor Arthur Schuster.

AT the recent annual meeting of the State Microscopical Society of Illinois the constitution and by-laws were revised and the following officers elected for the ensuing year:

President—David L. Zook.
First Vice-president—Walter F. Herzberg.
Second Vice-president—Francis T. Harmon.
Treasurer—Frank I. Packard.
Corresponding Secretary—N. S. Amstutz.
Secretary—V. A. Latham.
Curator—Henry F. Fuller.
Trustees—M. D. Ewell, B. U. Hills, Albert McCalla, S. S. Graves and W. G. King.

An annual conversazione meeting will be held on March 12 at the rooms of the Chicago Press Club. The annual soirée in connection with the Chicago Academy of Sciences, Lincoln Park, will be held some time in April.

"MEN of the Old Stone Age in Europe: their Environment, Life and Art" was the subject of the annual Hitchcock Lectures, just given at the University of California as the series for 1914. This year's Hitchcock Lecturer was Dr. Henry Fairfield Osborn, research professor of zoology in Columbia University, and president of the American Museum of Natural History. The latest fruits of excavation and comparative study in various parts of the world were gathered together by Professor Osborn in these lectures. He told of *Pithecanthropus*, the earliest human type as yet discovered; of the recent important English discovery of the Piltdown man; of the Heidelberg man; of the Neanderthal human type; of the Crô-Magnon race, and of the local Grimaldi race. He described the mural art of such caverns as those of Font de Gaume, in France, and Pasiega, Castillo and Altamira, in Spain. After telling of the appearance of the Grenelle race and the Azilian-Tardenoisian culture, he completed his lectures with an account of the beginning of the Neolithic Period, its culture and the sources of its main races.

DR. W. M. DAVIS, Sturgis-Hooper professor emeritus at Harvard University, has gone from Cambridge on a trip to several of the island groups in the Pacific Ocean, where he will study coral reefs. On the outward voyage he will visit the Fiji and other islands, in August he will attend the colonial meeting of the British Association to be held in Australia, and in September will take part in a supplementary meeting promoted by the government of New Zealand. On the return voyage, he will stop at the Society Islands. The trip is made possible by a grant from the Shaler Memorial Fund. Professor Davis lectured before the Colorado Scientific Society at the State School of Mines, Golden, Colo., on "The Front Range of the Rocky Mountains," February 3; at the State University, Boulder, Colo., on "Theories of Coral Reefs," February 4; at Brigham Young University, Provo, Utah, on "The Lessons of the Colorado Canyon," February 6, and before the Leconte Club at the University of California, Berkeley, Cal., on "The Topographic Features of Desert Regions," February 10.

THE Cutter lectures on preventive medicine and hygiene are to be given at the Harvard Medical School this year by Charles V. Chapin, M.D., superintendent of health, Providence, and Dr. Cressy L. Wilbur, chief statistician, Bureau of the Census. Dr. Chapin will give six lectures on municipal sanitation, as follows:

March 20, "Science and Sanitation."
March 27, "Efficiency of Public Health Measures."
April 2, "Organization of the Health Department."
April 9, "Research and Publicity."
April 16, "Nuisance Problems."
April 30, "Contagious Disease Problems."

Dr. Wilbur's subject will be "Vital Statistics in Massachusetts and the United States," and the dates are March 25 and 26.

DR. JOHN M. CLARKE, state geologist of New York, lectured before the Society of Sigma Xi of the Ohio State University on December 27, his subject being "Land Bridges Across the Atlantic."

Professor Arthur H. Blanchard, of Columbia University, on February 24, delivered illustrated lectures at the University of Tennessee on the subjects: "Bituminous Macadam and Bituminous Concrete Pavements" and "Highway Engineering in Europe" and an illustrated lecture on "City Pavements," before the chamber of commerce of the city of Knoxville.

Professor J. Ansel Brooks, of Brown University, on March 2, delivered an illustrated lecture on "The Principles of Efficiency Engineering applied to Highway Engineering," before the graduate students in highway engineering at Columbia University.

On February 28 Sir J. J. Thomson began a course of six lectures at the Royal Institution on recent discoveries in physical science.

Portraits of Dr. John Herr Musser, late professor of medicine in the University of Pennsylvania, and of Dr. Rush Shippen Huidekoper, first dean of the school of veterinary medicine, were presented to the University of Pennsylvania at its university-day celebration on February 23.

Mr. and Mrs. Paul J. Sachs have established a fund for the American Museum of Natural History to be known officially as the Angelo Heilprin Exploring Fund. The money is given in memory of Angelo Heilprin and is to be applied each year to any exploring purpose the museum authorities deem fitting.

Memorial services for Alfred G. Compton, late professor of physics at the College of the City of New York, were held on March 9 in the great hall of the college. Professor Compton entered the college at its foundation and was graduated with the class of 1853. Since his graduation until his retirement in 1911 he was a member of the faculty. Among those who made addresses were: Professor Michael I. Pupin, of Columbia University; Professor Adolph Werner, of the college, and Dr. John H. Finley, state commissioner of education and formerly president of the college.

Professor Edwin J. Houston, formerly of the Central High School of Philadelphia and the Franklin Institute, well known for his work in electrical engineering and for his writings on this and other departments of physics, died on March 1, aged seventy years.

Colonel Alexander Ross Clarke, the distinguished British geodesist, died on February 11, at the age of eighty-five years.

Dr. Julia Cock, consulting surgeon to the New Hospital for Women and dean of the London School of Medicine for Women, died on February 7, aged fifty-four years.

The U. S. Civil Service Commission announces an examination for junior pharmacologist, on April 8, to fill vacancies in this position in the bureau of chemistry, Department of Agriculture, Washington, D. C., at salaries ranging from $1,200 to $1,500 a year.

John Dewrance has presented £2,000 to the donation fund of the Royal Society. The income arising from this fund is applied in promoting experimental researches.

The Bermuda Biological Station for Research will be opened in June for a period of about six weeks. Members have facilities for shore collecting, dredging and marine towing down to a depth of 100 fathoms. Inquiries should be sent to Dr. E. L. Mark, 109 Irving St., Cambridge, Mass.

According to the resolutions of the meeting of October 25, 1912, at Lyons, the secretary's office of the permanent committee for the International Veterinary Congresses has been definitely established at The Hague from January 1, 1914, under the patronage of the Dutch Department of Agriculture, Industry and Commerce. The address of the office is as follows: "Secretary's Office for the Permanent Committee for the International Veterinary Congresses at The Hague, Stationsweg 74 (Int. Tel. 848)." Correspondence, publications, etc., as far as they are not sent to the president of the committee, Dr. A. Lydtin, at Baden-Baden, or to the secretary, Professor Dr. D. A. de Jong, at Leyden, are to be addressed to this office.

With the cooperation of fifty different organizations devoted to social progress and civic welfare, Reed College will hold a conference on May 15, 16 and 17, as a clearing house for

welfare workers and a stimulation for the activities of the city for the year 1915. This Portland 1915 conference will be similar in scope and method to the Reed College conference on the conservation of human life held last May.

A NEW edition of "Les observatoires astronomiques at les astronomes," first published in 1907, is in course of preparation, under the direction of members of the Royal Observatory of Belgium, with Professor P. Stroobant as chairman. He will be glad to receive information from directors of observatories and private astronomers concerning their work and publications.

UNIVERSITY AND EDUCATIONAL NEWS

THE College of Agriculture and the Mechanic Arts of North Carolina is preparing to celebrate on the first three days of October the twenty-fifth anniversary of the first opening of the college. A tentative program has been adopted at a meeting held in the office of Governor Locke Craig, who is *ex officio* chairman of the board of trustees and at the head of the advisory committee which is cooperating with the committee of arrangements. In order to make the quarter-centennial celebration a complete success, efforts will be made to have in connection with it reunions of the twenty-two classes which have so far been graduated. There will also be social meetings, addresses by some of the distinguished men who took part in the founding of the college, and other interesting features. The celebration proper will take place on the morning of October 3, with the principal addresses, but the other meetings will not be at all lacking in interest. Guests who will be held in special honor throughout the celebration will be those who took part in the movement which resulted in the founding of the college.

THE faculty and students of the University of Pittsburgh held a banquet on February 25.

AT the end of the current college year, Dr. Albert Benedict Wolfe, head of the department of economics and sociology, will withdraw from the Oberlin faculty in order to accept the headship of the department of sociology and economics in the University of Texas.

PROFESSOR O. PERRON, of Tübingen, has accepted the professorship of mathematics at Heidelberg, as successor to Professor L. Koenigsberger.

DISCUSSION AND CORRESPONDENCE

STANDARD UNITS IN AEROLOGY

IN SCIENCE, January 2, 1914, p. 31, it is stated that Blue Hill Observatory would use the new units for atmospheric pressure and temperature, *i. e.*, the units proposed by Köppen at Monaco in 1909 and again by V. Bjerknes at the Vienna meeting of the International Commission for Scientific Aeronautics, 1912. In this system, pressure is expressed in bars or decimal parts thereof, such as decibar, centibar and millibar. One million C.G.S. units constitutes a bar.

Professor A. E. Kennelly, visiting this observatory, called attention to the inconsistency of such use of the term "bar." Unknown to meteorologists at home or abroad, apparently, the bar has been defined and used with a different value. Professor T. W. Richards in 1903,[1] suggested that the pressure of a dyne per square centimeter be called a bar;[2] and while investigation shows that somewhat similar suggestions had been made by others, Richards's was independently made, original and legitimately deduced. Kennelly[3] and others following Richards have used the bar in this sense. It has therefore priority of definition and usage and is moreover the logical and appropriate unit of pressure. For the unit proposed by the aerologists, a more fitting designation would have been "aer" or "atmos."

Unless some protest be made against the proposed bar of the aerologists, we add to the confusion of units and terms already existing in meteorology. It is important too that we

[1] Publication 7, Carnegie Inst., 1903, p. 43.

[2] "New Method of Determining Compressibility," T. W. Richards and W. N. Stull, *Jour. Am. Chem. Soc.*, Vol. XXVI., April, 1904.

[3] "Convection of Heat from Small Copper Wires," A. E. Kennelly, C. A. Wright and J. S. Van Bylevelt, *Trans. Am. Inst. Elec. Engineers*, June, 1909.

make the correction *now* at a time when we are trying to break away from the old order, attempting to introduce rational units in place of the old arbitrary ones. It is somewhat embarrassing for one who has advocated the introduction of absolute units to acknowledge the validity of the criticism of chemist, physicist and engineer; but fortunately the corrections can be made readily by changing the millibar of the aerologist to kilobar. In the conversion tables which are in course of preparation, this will be done.

Briefly, the term "barad" was proposed by a committee of the British Association for the Advancement of Science, 1888, as a suitable term for the unit of pressure, one dyne per square centimeter. Some years later Ostwald advocated the use of one million of these units as the standard, but gave the standard no name. The term *bar* was proposed by Richards in 1903 for the small unit of pressure, one dyne per square centimeter; and *megabar* for a C.G.S. atmosphere. So far as I can ascertain this is the first case in which a clear-cut definition of an absolute atmosphere has been used in actual investigation. He has consistently used this unit megabar as the basis of his work ever since. Richards's atmosphere is 0.987 of the ordinary sea-level atmosphere or 1.020 kilograms per square centimeter; and under the new order agrees with the standard level of Köppen, the million-dyne level at about 106 meters elevation.

It seems almost unnecessary to argue that the smaller bar should be the basic unit and not some multiple. And again it is doubtful if bar is the best designation for the pressure of an absolute atmosphere. Megabar is not altogether inappropriate and has priority of usage especially in the literature of chemistry. A megabar in the aerologist's notation would be the pressure of a million atmospheres, a magnitude not often dealt with. On the other hand, we often need to refer to pressures smaller than the millibar of the aerologist. The bar of the chemist and physicist is conveniently divisible down to its millibar, *i. e.*, a thousandth of a dyne per square centimeter.

The following table contrasts the two systems. At Dr. Richards's suggestion it is restricted to those terms most likely to be used.

Chemist's and Physicist's (to be Universally Used Hereafter)	Former Aerologist's (to be Abandoned)	Remarks
....	1 megabar	One million atmospheres, far beyond our present possibilities of direct measurement.
1 megabar	1 bar	The absolute atmosphere; equal to 750.1 mm. mercury or .987 usual sea-level atmosphere. One megadyne per square centimeter acting through one cubic centimeter does one megerg of work.
1 kilobar	1 millibar	One kilodyne per square centimeter.
1 bar	........?	One dyne per square centimeter acting through one cubic centimeter does one erg of work.

There would be no objection to giving the term megabar or absolute atmosphere some convenient nickname such as "aer" if megabar is too ponderous. It has been suggested by Professor Richards that for historical reasons the pressure of 10,000,000 dynes (ten absolute atmospheres) might be named after some pioneer in meteorology, as Guericke or Torricelli, after the analogy of the "watt," "joule," "ampere," etc., but this need not be insisted on at present.

ALEXANDER MCADIE

BLUE HILL OBSERVATORY,
February 28, 1914

ACADEMIC ELECTIONS

TO THE EDITOR OF SCIENCE: In connection with the table of percentages accompanying my article on "Academic Student Elections," in SCIENCE for January 16, a correspondent has called my attention to some inaccuracies in copying percentages from Professor Ferry's tables, on which the article was based. With one exception they do not seem very important. This exception is in connection with the work in biology at Bowdoin College. The entry was from the wrong column of Professor Ferry's extended table, and to Bowdoin was assigned the lowest record in this subject. A

considerably lower record, more than a third lower, belonged to another institution.

It seems only fair to Bowdoin College, and especially to its professor of biology, to publish this correction of an unfortunate oversight.

W. LeConte Stevens

Lexington, Va.,
January 31, 1914

SCIENTIFIC BOOKS

Chippewa Music. II. By Frances Densmore. Smithsonian Institution. Bureau of American Ethnology. Bulletin 53. 1913. Pp. 314. 51 illustrations. 180 songs. 14 tables giving "melodic analysis of 340 songs." 7 tables of "rhythmic analysis" and a table giving "comparison of metric unit of voice and drum."

Bulletin 53 together with bulletin 47 (1910) are devoted to Miss Densmore's study of Chippewa music begun in 1907 and brought to a close in the present volume. In this bulletin the author presents the results of six years of labor, gathering songs from the Chippewa in their native environment and making careful studies of the songs themselves. By these means she has sought to answer three questions: What do the Chippewas sing? How do they sing? Why do they sing? The answers to the first two are presented in a clear, painstaking manner and in such form as to make them conveniently serviceable for comparative study. The third question is concerned with the psychological aspects of Indian song and consequently its answer could not easily be formulated in the same manner as those relating to the other two questions, nevertheless the author has recorded her observations on this point among the Chippewa. Truthfulness and earnestness of purpose characterize this book as well as an appreciation of the people from whom the material was secured. The work has a special value to the student of musical development and presents points of interest to the ethnologist. The Bureau of American Ethnology is to be congratulated upon its entrance into an important field and particularly upon its selection of so able and scholarly an investigator as Miss Densmore to conduct this difficult line of research.

An ample index adds to the usefulness and pleasure of the book. Alice C. Fletcher

Fosseis Devonianos Do Paraná. Pelo Dr. John M. Clarke. Monographias do Servico Geologico E Mineralogico do Brasil. Vol. I., Rio de Janeiro. 1913. Pp. xx + 353; pl. I.–XXVII.

A monograph upon the Devonian of the state of Paraná, Brazil, which has been published recently by the Geological Survey of that country, constitutes a notable contribution to our knowledge of the geology of South America. The author of the work is Dr. John M. Clarke, the accomplished state geologist of New York. Long an investigator of the Devonian of that state, he has recently issued a number of monographs upon strata of the same age in both North and South America, including works upon the Lower Devonian of the Gaspé region, Canada, and upon the Devonian of the State of Pará, Brazil. To these he has now added this important monograph upon the Devonian of Paraná.

The volume consists of two parts. The first part comprises a discussion of the character and significance of the Devonian faunas of the region studied, while the second is devoted to a description of the species, with critical comments upon their relations to those of other areas.

The Devonian of America presents two broadly conceived types: a northern or boreal, confined chiefly to North America and the region north of the Amazon, and a southern or austral type. Dr. Clarke shows that the Devonian sediments found in South America, from central Brazil southward, contain an austral fauna. The latter, which differs from the boreal fauna in many respects, is a unit throughout its range, having definite and recognizable characteristics wherever found.

While the work before us is entitled a discussion of the Devonian Fossils of Paraná it is in reality a monograph upon the austral Devonian of the whole of South America. The author gives a critical discussion of the

strata and fauna of this facies not only in Paraná, but also in the state of Matto Grosso, Brazil, Bolivia, Argentina and the Falkland Islands. The work hence possesses a wide scope.

The stratigraphic succession in Paraná is as follows, in descending order: Tibagy sandstone, Ponta Grossa shales, Furnas sandstone. The strata are underlain by an ancient, crystalline complex, and are overlain by Permo-Carboniferous deposits containing glacial till. A very interesting member of this series is the barren, basal Furnas sandstone, which appears to be paralleled by a similar sandstone situated at the base of the Devonian in Bolivia and Argentina. It overlies, at different places, ancient crystallines, Cambrian and Silurian strata, and hence seems to indicate a widespread transgression of the sea in South America at the beginning of Devonian time.

The austral fauna is believed by Dr. Clarke to be of Lower Devonian age, and is considered by him to have sprung from a boreal Silurian ancestry, owing its peculiarities to its development in isolation in southern waters.

One of the most notable aspects of the discussion is the fact, brought out with great clearness, that the American austral Devonian fauna finds its nearest relative in the Bokkeveld fauna of the same age in South Africa. Indeed the species of the Falkland Islands are more closely akin to those of South Africa than they are to those of the state of Paraná.

These relations lead to an interesting reconstruction of the lands and continents of Devonian time. The existence of a more or less intimate connection between Africa and South America had been foreshadowed with greater or less clearness by various writers. The author suggests that an Antarctic continent existed at that time, whose strand stretched from South Africa to the Falkland Islands and thence north into Chile and Argentina, along which the austral species migrated. A large island situated near the present state of Paraná was separated from the Antarctic continent by a comparatively narrow waterway.

A northern land mass embraced the northern part of South America and a large area on the site of the present North American continent. A land bridge is believed to have extended across the north Atlantic ocean, uniting North America and Europe, its existence being indicated by the close relation of the early Devonian faunas of Maine to those of the Coblentz district on the Rhine. It is thought probable that the center of dispersion of the austral species was located in central Africa. The division of the Lower Devonian faunas into a boreal and austral facies and their geographic distribution are explained by these facts.

The larger part of the monograph is devoted to a description and critical discussion of the species constituting the austral Devonian fauna of South America and a consideration of their relations to those of South Africa.

Illuminating comments are made upon the distinguishing characteristics of the austral types in connection with the discussion of the leading groups, the treatment of the characteristics of the trilobites being especially valuable.

The work is published in the English and Spanish languages in parallel columns. Its illustrations are of a high order of excellence. The monograph is a notable contribution to our knowledge of the geology of South America and is a credit both to the author and to the Geological Survey of Brazil.

CHARLES K. SWARTZ

BALTIMORE, MD.

SPECIAL ARTICLES

A NEW CYTOLOGICAL STAINING METHOD

DURING the course of an investigation on spireme formation and chromosome number in the pollen-mother cells of various species of *Lilium* and *Nicotiana*, considerable time was expended in testing and experimenting with stains and staining processes. In plants such as *Nicotiana*, where the chromosomes are small and the characteristic number is large (48) (24), it is desirable, especially in certain phases of the maturation phenomena, to have a stain combination which will differentiate

chromosomes sharply from the other cell material and at the same time produce a chromosome stain translucent enough so that each chromosome in a crowded equatorial plate will stand out by itself. In the synapsis condition of the spireme, a translucent but extremely "contrasty" differentiation between the tightly massed thread and other cell materials was also thought desirable. Flemming's safranin, gentian violet, orange G combination and iron hematoxylin were usually unsatisfactory in attempting to secure the sought-for results.

Magdala-red was tested out after the methods given by Chamberlain,[1] but with unsatisfactory results. Both strong and weak solutions of the stain were used, but for chromatin and chromosome staining it never appeared to possess "body" enough to give a sharp contrast when used with anilin-blue or other blue cytoplasmic stains. After a preparation had been in the stain bath for 24 hours, the red color easily washed out during the hurried passage through acid alcohol, 95 per cent. neutral alcohol, etc., to xylol. Occasionally fair preparations were obtained, but when these were examined by artificial light, the red stain, through lack of "body," lost its brilliancy and contrast value.

The thought occurred to try mixing magdala-red with safranin O, and thus remedy the "lack of body" defect of the former and increase the brilliancy and translucency of the latter. Accordingly, a solution of safranin, made up of equal parts saturated solution of safranin O in 50 per cent. alcohol and a saturated solution of safranin in a 3-per-cent. solution of anilin oil in water, was mixed with a strong (saturated) solution of magdala red in 9 per cent. alcohol. The precipitate thrown down upon mixing the two stains was eliminated by filtering and the red solution remaining was used as the stain. Serial section preparations on the slide were allowed to remain in this stain for varying lengths of time—24 hours in most cases, after which they were treated with anilin-blue, etc., after the method as given by Chamberlain, p. 48. Many variations in method were practised; the main thing being to allow the red stain to act for a long time and the blue a very short time. The necessity of using the hydrochloric acid to bring out the brilliancy of the anilin-blue and to produce the desired contrast effect made the process undependable where good preparations were constantly desired. In other words, where only a small amount of material was to be had and every slide preparation must be made to count, as in much research work, the method was not a practicable one.

In order to eliminate the use of acid, the anilin-blue was discarded, and a saturated solution of azure II was substituted. This combination of magdala-red-safranin and azure II gave in most cases good results. A brilliant red and blue were both obtainable without the use of acid. From the solution of magdala-red-safranin, the slide was dipped directly into the azure II, allowed to remain about a second, and then rushed through the higher alcohols to xylol and neutral balsam. Variations in practise were common and it has been my intention here merely to indicate the general method. In many cases, satisfactory results were obtained by shortening the bath in the red stain to an hour or even to 30 minutes.

Preparations of reduction division stages in the pollen-mother-cells of *Lilium canadense* L. were stained as follows: cytoplasm, deep brilliant royal blue or greenish blue; spindle fibers dark blue and sharply outlined against the cytoplasm; nucleoli, usually blue in active and red in "resting" nuclei, chromatin substance (spireme, etc.) brilliant deep ruby red. Preparations of pollen-mother-cells of *Nicotiana* in early prophase have been obtained in which the vacuolated nucleoli were stained blue and little beadlike globules within the nucleolar vacuoles shown brilliant red. The chromatin is aways stained a brilliant red and against the background of dark blue cytoplasm the contrast is extremely sharp. Chromosomes in those plants where their numbers are large are ordinarily counted with extreme difficulty, even under the most favorable conditions, owing to the crowding of the chromosomes on

[1] "Methods in Plant Histology," 2d ed., 1905, pp. 42, 44, 47–48, 79–83.

the spindle. The process just described will, I believe, partially eliminate this difficulty, as the red is somewhat translucent and each chromosome seems to stand out by itself, even when one lies above the other. Mature pollen of *Lilium tigrinum* Ker. when fixed in Flemming and embedded and sectioned in the usual manner reacts to the process as follows: outer wall, sculpturing, etc. (perine), bright red; extine, intine and cytoplasmic structures blue or bluish green; chromatin granules and nucleoli in "resting" nuclei, red; other nuclear material blue; nuclei as a whole well differentiated from surrounding cytoplasm.

ORLAND E. WHITE

BROOKLYN BOTANIC GARDEN,
January 31, 1914

THE AMERICAN MATHEMATICAL SOCIETY

THE society held two large meetings during the Christmas holidays, one at the University of Chicago on December 26–27, the other at Columbia University on December 30–31. The New York meeting was the annual meeting of the society, and was especially marked as the occasion of the presidential address of Professor H. B. Fine, on "An Unpublished Theorem of Kronecker Respecting Numerical Equations."

Eighty members attended the four sessions. Professors W. F. Osgood and H. B. Fine occupied the chair in succession. The following new members were elected: Professor Pierre Boutroux, Princeton University; Mr. E. H. Clarke, Purdue University; Dr. W. H. Cramblet, University of Rochester; Mr. H. J. Ettlinger, University of Texas; Professor W. S. Franklin, Lehigh University; Mr. H. Galajikian, Princeton University; Professor W. W. Hart, University of Wisconsin; Mr. Barnem Libby, University of Michigan; Mr. G. W. Mullins, Columbia University; Mr. J. A. Northcott, Columbia University; Dr. Mildred L. Sanderson, University of Wisconsin; Mr. J. M. Stetson, Princeton University. Nine applications for membership were received. The total membership of the society is now 710, including 66 life members.

The Treasurer's report shows a balance of $9,153.58. Sales of publications during the year have amounted to $2,111.45. The library has increased to 4,902 volumes. The number of papers read at all meetings was 240.

At the annual election the following officers and members of the council were chosen:

Vice-presidents: L. P. Eisenhart and E. J. Wilczynski.

Secretary: F. N. Cole.

Treasurer: J. H. Tanner.

Librarian: D. E. Smith.

Committee of Publication: F. N. Cole, Virgil Snyder, J. W. Young.

Members of the Council to serve until December, 1916: C. N. Haskins, L. M. Hoskins, E. V. Huntington, H. L. Rietz.

The annual dinner, on Tuesday evening, was attended by forty-seven members.

The Madison Colloquium Lectures, delivered last September by Professors L. E. Dickson and W. F. Osgood, are now in press and will soon be published by the society.

The following papers were read at the annual meeting:

L. L. Dines: "Complete existential theory of Sheffer's postulates for Boolean algebras."

Arnold Emch: "Two convergency proofs."

J. L. Coolidge: "Congruences and complexes of circles."

Dunham Jackson: "On the degree of convergence of Sturm-Liouville series."

Virgil Snyder: "Birational transformations of the cubic variety in four-dimensional space."

Miss A. H. Tappan: "Plane sextic curves invariant under a group of linear transformations" (preliminary communication).

C. L. Bouton: "Explicit formulas for the inverse of an analytic transformation in n variables."

Edward Kasner: "The classification of conformal transformations."

L. B. Robinson: "Questions of logic arising from the study of systems of partial differential equations" (preliminary report).

Pierre Boutroux: "On a family of rational differential equations of the first order."

H. B. Fine, presidential address: "An unpublished theorem of Kronecker respecting numerical equations."

W. A. Hurwitz: "Note on the Fredholm determinant."

G. D. Birkhoff: "The restricted problem of three bodies."

E. V. Huntington: "On the accuracy of the contracted form of Horner's method."

O. E. Glenn: "On an analogy between formal modular invariants and the class of algebraical invariants called Booleans."

G. C. Evans: "Green's functions for linear partial differential equations of the second order, and Green's theorem."

W. R. Longley: "An existence theorem for a certain differential equation of the nth order."

W. C. Graustein: "The real congruence of complex points, planes, lines."

H. W. Reddick: "Conformal invariants of orthogonal curve nets" (preliminary communication).

W. F. Osgood: "Liouville's theorem concerning periodic functions of several variables."

L. M. Kells: "A complete characterization of dynamical trajectories in n-space."

W. H. Cramblet: "A classification of discontinuous functions and some allied problems."

J. K. Lamond: "Note on the reduction of multiple L-integrals to iterated L-integrals."

L. A. Howland: "Functions of n variables which are functions of r combinations of these variables."

J. I. Tracey: "Covariant curves of the plane rational quintic."

A. B. Coble: "Restricted systems of equations."

L. P. Eisenhart: "Transformations of surfaces of Voss."

H. Galajikian: "A type of non-linear integral equation."

T. H. Gronwall: "On systems of linear total differential equations."

T. H. Gronwall: "Extension of Laurent's theorem to several variables."

T. H. Gronwall: "On approximation by trigonometric sums."

R. D. Beetle: "Cyclic systems of osculating circles of curves on a surface."

G. M. Green: "Canonical systems in projective differential geometry, with special reference to the theory of curved surfaces."

J. H. M. Wedderburn: "A type of primitive algebra."

F. N. COLE,
Secretary

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-first annual meeting of the American Society of Naturalists was held in the Zoological Laboratory of the University of Pennsylvania on December 31, 1913. In affiliation with the society this year were the American Society of Zoologists, the American Association of Anatomists and the Federation of American Societies for Experimental Biology.

A revised constitution and by-laws was adopted with several important modifications of the old constitution:

1. The former division of the society into an eastern branch and a central branch was abolished. "Sections of the society may be organized in any locality, with the approval of the society in each case, by ten or more members for the purpose of holding meetings for the presentation of scientific papers. Such sections shall have the right to elect their own officers and associate members, but associate membership in any section shall not confer membership in the society.

2. The executive committee is permitted at its discretion to remit for any year the annual assessment of one dollar.

3. The secretary and treasurer are to be elected for terms of three years each. An additional member of the executive committee is to be elected each year to serve for three years.

4. "A committee of three, consisting of the president, vice-president and secretary, shall arrange a program for each meeting."

5. "The records of the society shall be published once every three years, beginning in 1914."

6. "The society shall reimburse the secretary for traveling and hotel expenses incurred in attending the annual meeting."

The following were elected to membership in the society: Irving W. Bailey, Harvard University; Arthur M. Banta, Carnegie Station for Experimental Evolution; Harley H. Bartlett, Bureau of Plant Industry; Charles T. Brues, Harvard University; Philip P. Calvert, University of Pennsylvania; Mintin A. Chrysler, University of Maine; R. A. Gortner, Carnegie Station for Experimental Evolution; Milton J. Greenman, Wistar Institute; Robert W. Hegner, University of Michigan; Lawrence J. Henderson, Harvard University; Merkel H. Jacobs, University of Pennsylvania; G. L. Kite, Henry Phipps Institute; Ralph S. Lillie, Clark University; Clarence E. McClung, University of Pennsylvania; J. H. McGregor, Columbia University; Edward B. Meigs, Wistar Institute; J. Percy Moore, University of Pennsylvania; Alice Robertson, Wellesley College; Edmund W. Sinnott, Harvard University; Arlow B. Stout, New York Botanical Garden; P. W. Whiting, Harvard University.

The program of the morning session was as follows:

"Some Physiological Phases of the Study of Teratological Variations," by J. Arthur Harris.

"Some Physiological Observations Regarding the Genetic Factors for Plumage Patterns," by Raymond Pearl and Alice M. Boring.

"Twin and Triplet Hybrids from Wild Species of *Œnothera* with Segregation in the First Generation," by George F. Atkinson.

"The Functions of an Environment," by Lawrence J. Henderson (by invitation).

"A New Method of Analysis of Fertilization: Results and Theory," by Frank R. Lillie.

"On the Adaptation of *Fundulus* to Abnormal Salt Solutions," by Jacques Loeb. (Read by title.)

"Sex Recognition and Sexual Selection in Vertebrates," by Jacob E. Reighard.

"Endemic Species from Ancient Strands and Recently Observed Modifications of Seed-plants on the Beaches of the Salton Sea," by Daniel T. MacDougal. (Read by title.)

"Divergent Characters of the Progeny Arising from Seed Maturing in Treated Ovaries of *Scrophularia occidentalis*," by Daniel T. MacDougal. (Read by title.)

"Association of Hereditary Factors in Parthenogenetic Lines of *Hydatina*," by A. Franklin Shull.

"An Inherited Variation in the Strength of Linkage," by A. H. Sturtevant (by invitation).

"Size Inheritance in *Drosophila*," by Edward N. Wentworth. (Read by title.)

"Studies on Inheritance in Orthoptera," by Robert K. Nabours (by invitation).

"Physiological Resistance to Drought in F_2 Segregates of Certain Maize Crosses," by Herbert F. Roberts. (Read by title.)

"Partially Sterile Crosses between Species of *Nicotiana*," by Edward M. East. (Read by title.)

"Reciprocal Crosses between *Œnothera biennis* and *Œnothera muricata*," by Bradley M. Davis. (Read by title.)

The session of the afternoon consisted of a symposium on the subject "The Scope of Biological Teaching in Relation to New Fields of Discovery," Papers were presented by Michael F. Guyer, University of Wisconsin—Zoology; Mintin A. Chrysler, University of Maine—Botany; Robert R. Bensley, University of Chicago—Anatomy and Medicine; George H. Parker, Harvard University—General Physiology.

In the discussion following the reading of the four principal papers, Drs. Goldfarb, Atkinson, Loeb, Clapp, McMurrich, Morgan, McClung, Lefevre, Reighard, Henderson and Knower participated.

The Naturalists' dinner was held on the evening of December 31, at the Hotel Walton, with one hundred and ten in attendance. The president's address by Professor Ross G. Harrison was entitled "Science and Practise."

The officers of the Society for 1914 are:

President—Samuel F. Clarke, Williams College.

Vice-president—Frank R. Lillie, University of Chicago.

Secretary—Bradley M. Davis, University of Pennsylvania.

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution.

Additional Members of the Executive Committee—Raymond Pearl, Maine Agricultural Experiment Station; Ross G. Harrison, Yale University, and Elias P. Lyon, University of Minnesota.

BRADLEY M. DAVIS,
Secretary

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

THE sixty-fifth meeting of Section E, Geology and Geography, of the American Association for the Advancement of Science was held in the senate chamber of the state capitol, Atlanta, Ga., December 28, 1913, to January 1, 1914. Vice-president J. S. Diller presided. Professor U. S. Grant, Northwestern University, Evanston, Ill., was elected vice-president of the association and chairman of Section E for the next meeting to be held in Philadelphia. Dr. E. H. Sellards, state geologist of Florida, was elected a member of the council, Dr. David White, United States Geological Survey, a member of the sectional committee, and Dr. S. W. McCallie, state geologist of Georgia, a member of the general committee.

In connection with the meeting the following resolutions were unanimously adopted:

WHEREAS, it is recognized that the American Association for the Advancement of Science is the great scientific organization of this country, and,

WHEREAS, it is hoped that this organization may continue to fulfil its great function as the representative of science in America,

Be it Resolved, that it is the sense of Section E, an important branch of the parent organization, that the strongest men interested in geology and geography should be urged to assist in every way possible in promoting the best interests of the general organization,

Furthermore, in the belief that these purposes can be most effectively accomplished by the cooperation of existing geological and geographical organizations, it is recommended that every effort be made to have the meetings of the Geological Society of America and the Association of American Geographers held, as frequently as possible, in connection with those of the American Association for the Advancement of Science,

It is Further Recommended, that the officers of Section E, with the approval of the council, be instructed to take such steps as are necessary to secure the desired results.

The address of the retiring Vice-president, Professor J. E. Todd, was given on the subject, "Pleistocene History of the Missouri River."

The program consisted of more than thirty papers, the majority of which dealt with the mineral resources of the southern states. It is hoped that all the papers on the mineral resources of the southern states may be published in one volume. As an aid to such publication the council voted the sum of $200.

The titles and abstracts of papers presented before Section E are given below:

Mineral Resources of the Southern States—Distribution and Production: J. S. DILLER. (Illustrated by map and collection of specimens.)

In opening the discussion of the mineral resources of the southern states, Mr. Diller called attention to a large wall map recently prepared by the United States Geological Survey to show the distribution of the most important mineral resources of the sixteen states included in the southern section.

Of the various mineral products found in the United States only two, borax and platinum, are not produced in the southern states but, on the other hand, some of the southern states are the largest or exclusive producers of nearly a dozen substances, among which phosphate rock, manganese, bauxite, sulphur, barite and fuller's earth occur.

There are 55 different mineral substances won from the earth in the southern states, and of these a collection consisting of more than a hundred specimens was exhibited at the meetings of Section E.

Coal is the resource of first importance. The value of coal alone produced in 1912 was more than 144 million dollars, with large reserves, as shown on the map, that will last for centuries.

The total production of mineral resources in 1912 was $401,399,483.

Nearly a score of other substances in addition to coal were produced in the same region to the value of more than a million dollars each, and while the distribution of the reserves of these resources was shown on the large map the value of the production of each during 1912 was shown on a chart.

It is expected that the map and chart will be published in connection with the volume of papers read before Section E on the mineral resources of the southern states.

The Coal Resources of the Southern States: L. C. GLENN.

This paper summarized our knowledge of the coal resources of the southern states, indicated the trend of present developments, and showed the importance of the rôle to be played by coal in the future industrial development of the south. It was illustrated by charts and diagrams.

The Petroleum Resources of the Southern States: D. W. OHERN.

The Marbles and Granites of the Southern States: S. W. MCCALLIE.

The geographical and geological distribution, history and extent of development, physical and chemical characteristics, and commercial uses of the marbles and granites of the southern states.

The Mines and Quarries of Georgia: S. W. MCCALLIE. (Illustrated with lantern slides.)

The Piedmont Limestones of the Southeast Atlantic States: THOMAS L. WATSON AND J. S. GRASTY.

This paper discusses the occurrence and distribution, structural and age relations, composition and uses of the Piedmont limestones of the southern Atlantic states, including Maryland to Alabama. It points out their much wider distribution than has been formerly supposed and suggests their Lower Cambrian (Loudoun) age. Besides being of economic importance in many of their occurrences, these limestones form extremely important and valuable guide members in the structural work necessary to determine the stratigraphic and age relations of the associated rocks.

The Limestones of Maryland, East of the Blue Ridge: J. S. GRASTY.

This paper is devoted to the various occurrences of limestone in the Piedmont section of Maryland, and embraces a discussion of their age, stratigraphy, structure and economic importance. With the exception of the occurrences in the Frederick Valley, and in the vicinity of Baltimore, practically no attempt, based on systematic study, has been made heretofore at a correct correlation. It is believed that it can be shown definitely and satisfactorily that the limestones in the middle part of this physiographic division (Piedmont) of Maryland should be assigned to the Potsdam group of the Cambrian, though-be-it this is at variance with the general geological impression, which is that they are older, a view entertained, perhaps, because of their association in areal occurrence with other rocks definitely known to be pre-Cambrian.

The Slate Deposits of the Southern States: J. S. GRASTY AND J. H. CLINE.

This paper is devoted to a discussion of the more important slate deposits of the southern states, including their location, structural and age relations, quality, etc., particular attention being given to those areas occupied by active operations. This accounts, therefore, for the prominent position and greater space being given in this discussion to the occurrences in Virginia and Maryland. Slates occur also in Georgia, notably the green slate found to the north of Cartersville, and in Arkansas, Tennessee, West Virginia and elsewhere in the south.

The Cement Materials and Industry of the Southern States: THOMAS L. WATSON AND J. S. GRASTY.

The Portland cement industry in the southern states is an important and growing one. Calcareous (limestones or marls or both) and argillaceous (clays, shales and slates) materials are found in each of the southern states, being particularly well developed in those states traversed by Ordovician, Silurian and Devonian rocks. The present paper discusses the occurrence and distribution of these materials, including composition, and explains how their adaptability for use in the manufacture of Portland cement may be determined.

The Gypsum Resources of the Southern States: FRANK A. WILDER.

Gypsum in quantities sufficient to be of commercial importance occurs in Oklahoma, Texas and Virginia. In Arkansas large deposits are said to exist in Pike county but their fitness for plaster can not be positively stated. A small body of gypsum is reported from Bear Island near the post-office of Panassoffke, Fla., but this deposit is of doubtful commercial importance.

The deposits in Oklahoma and Texas are inexhaustible and consist of both rock gypsum and gypsum earths known as gypsite.

The Virginia deposit is much more limited in area and in tons available, but can probably maintain an annual output of 200,000 tons for fifty years or more.

The Virginia gypsum deposit is peculiar on account of the rather unusual relationships between the gypsum and a pronounced fault which has thrust Cambrian dolomite over the gypsum-bearing formations which we regard as of Mississippian age.

On account of the rapid increase in the use of gypsum plasters, gypsum tile for fireproofing, and in portland cement, of which gypsum is a minor but very essential ingredient, these gypsum deposits are important factors in the development of the south.

In connection with agriculture ground gypsum is regarded as essential in the raising of peanuts and is useful in the cultivation of all legumes. It doubtless is the cheapest way to restore sulphur to the soil where this element has been exhausted, and reacts on insoluble potash compounds, rendering them more soluble.

The Gypsum Resources of Texas and Oklahoma: E. T. DUMBLE.

The location and character of the gypsum deposits of Texas and Oklahoma now being exploited commercially. Present development of the industry, and possibilities of this area. Description of other areas in Texas susceptible of similar development.

The Bauxite Industry in the Southern States: W. C. PHALEN.

The production of bauxite in the United States in 1912 was, in round numbers, 160,000 long tons, valued at approximately $775,000. In other words, this means the production of bauxite in the southern states, for the mining of this mineral is strictly a southern industry, and such it has been since its inception in the United States.

The states which produced bauxite in 1912 are as follows: Alabama, Arkansas, Georgia and Tennessee. A deposit of the mineral is known also in Botetourt county, Virginia, but it has never been exploited. Arkansas led in the production, as it has for many years, followed distantly by Georgia, Alabama and Tennessee, named in the order of their production and the value of same.

Bauxite has a variety of uses, which are as follows: (1) As raw material in the production of metallic aluminum, (2) in the manufacture of aluminum salts, (3) in the manufacture of bauxite brick, (4) in the manufacture of alundum (fused alumina) for use as an abrasive, and (5) in the manufacture of calcium aluminate.

The use of bauxite in the manufacture of metallic aluminum is by far the most important of those enumerated above. A large part of the entire output of Arkansas is used in the aluminum industry, and the production from this state has shown phenomenal growth during recent years. When it is considered that more than 65,000,000 pounds of the metal were consumed in the United States during the past calendar year, and that this aluminum in the form of No. 1 ingots, whole-

sale lots in New York City varied in price per pound from 18½ to 27 cents, the importance of the relation of bauxite production to what promises to be one of our most important future metallic industries becomes apparent, as does also the importance of a careful search for future supplies of the mineral.

The Outlook for the Aluminum Industry in the South:

Two water-power installations of great magnitude, for the manufacture of metallic aluminum, are now in process of construction in the southern states. One of these is by the Southern Aluminum Company and the other by the Aluminum Company of America. The former, with a capital of several million dollars, has been organized by an amalgamation of foreign aluminum interests, chiefly French, together with certain metal interests in the United States, and has acquired a water-power site on the Yadkin River, near Whitney, North Carolina. The company is now engaged in the development of the property, and has plans to erect, eventually, a complete plant with large capacity for the manufacture of the metal.

In addition, the Aluminum Company of America has acquired certain riparian rights in North Carolina and Tennessee, and has undertaken preliminary developments on the Little Tennessee River near the Tennessee-North Carolina boundary. The plans contemplate a water-power development of great magnitude, together with a reduction works at Maryville, 16 miles south of Knoxville.

The consummation of two such projects as those mentioned should prove a tremendous stimulus to the search for new deposits of bauxite in the south.

The Phosphate Deposits of the Southern States: E. H. SELLARDS.

The southern states at the present time are preeminently the source of phosphate rock in the United States, the total rock mined elsewhere in America being not more than 10,000 or 11,000 tons per annum. In fact this section contributes fully one half of the phosphate of the world. The statistics for 1910, the latest date at which approximately complete returns are available show the world's production of phosphate to be 5,156,671 metric tons, of which the United States produced 2,697,468 metric tons, or slightly more than one half, all of which with the exception of 11,612 tons was from the southern states. The production in the southern territory during 1911 was 3,420,774 long tons, while Florida alone in 1912 produced 2,579,865 long tons.

The phosphate deposits in the southern states are widely distributed and are diverse in their origin and manner of occurrence. Those states that are actively producing rock are: Arkansas, Tennessee, South Carolina and Florida. At least five other states, namely, Kentucky, Virginia, North Carolina, Georgia and Alabama are known to have phosphate, or phosphatic marls of agricultural value. The phosphate deposits of North Carolina and Kentucky have been mined to a limited extent. Those of Georgia and Alabama have been partially prospected, while the Virginia phosphates have been but recently discovered.

The methods used in mining the phosphate rock are, as a rule, neither complicated nor expensive. The open pit method is used for those deposits that have a removable overburden, while underground mining is resorted to only for those bedded deposits that are interstratified with other formations so that the overburden can not be removed. The chief production at the present time is from the open pit mines. After being taken from the mine the rock is washed and dried for shipment, almost one half being exported.

The Tennessee Phosphates: T. POOLE MAYNARD.

The phosphate deposits of Tennessee rank next in importance to those of Florida.

These deposits are found in what is known as the Central Basin of Tennessee, and in the valleys of the western part of the Highland rim surrounding this basin. Nodular deposits of black phosphate are found to the northeast of the Highland Rim in Putnam county.

All of the phosphates are found associated with rocks of sedimentary origin and occur in rocks of Ordovician and Devonian age.

There are three important classes of phosphate rock, while there are many characteristic differences among these classes. The brown, the blue and the white phosphate represent the three important classes. While the black rock phosphates of Putnam county are not economically important they form a fourth class.

The Salt Industry of the Southern States: W. C. PHALEN.

The five southern states which produce salt on a commercial scale, named in the order of their importance, are Louisiana, Virginia, Texas, West Virginia and Oklahoma. In the year 1912, the latest for which statistics are available, the output of salt in the states mentioned amounted to

nearly 350,000 short tons, or nearly 2,500,000 barrels, of 280 pounds each, valued in ronnd numbers at $725,000.

In Louisiana salt occurs in two districts, (1) in the north-central and northern part of the state in the valleys of the Red and Sabine rivers, and (2) in the southern part; the most important known deposits, and those worked at present, occurring in close proximity to the gulf coast. Rock salt is the product, mined at Weeks and Avery's islands, so-called, located in Iberia parish, very close to the Gulf of Mexico.

The only economically important deposits of salt found in Virginia occur in the southwest part of the state. These, with the gypsum deposits, extend for twenty miles along the valley of the north fork of the Holston River, and have been developed quite extensively in Smyth and Washington counties. Two gypsum plants and one alkali works, which utilizes the brines, are in operation in this area. Saltville, Smyth county, is the center of the alkali industry.

The important salt industries of Texas are located at Palestine, Anderson county, Grand Saline, Van Zandt county, in the eastern part of the state, and at Colorado, Mitchell county, in the western part. The bulk of the salt marketed in Texas is the evaporated article produced by the grainer process, but considerable also comes from the inland salt lakes in the western part of the state and from the lagoons along the southwestern coast.

In West Virginia the industry is confined to the Ohio River Valley and to the valley of the Kanawha River, a few miles above Charleston, the state capital. The product is evaporated salt produced by the grainer process. Bromine and calcium chloride aro also produced on a considerable scale, in connection with the manufacture of salt.

In Oklahoma the salt industry is small, and is confined to the salt plains in the southwestern part of the state.

The Asbestos Deposits of Georgia: Oliver P. Hopkins.

Asbestos representing three modes of occurrence is found in Georgia. Chrysotile, occurring in serpentine derived from peridotite, is present in insignificant quantities in a few localities where it gives no promise of commercial importance. Asbestos of the amphibole variety in slip-fiber veins occurs at widely distributed points over the Piedmont area of the state; while mass-fiber asbestos, which represents the important deposits from a commercial point of view, is restricted, in general, to the belt of peridotites and pyroxenites which cross the state in a southwest direction from Rabun county to Harris county, but is relatively most important in Rabun, White and Habersham counties than any others. Judging from the field relations and the microscopic study, it has been concluded that the mass-fiber anthophyllite has been derived from enstatite-olivine rocks.

Mass-fiber asbestos, owing to the nature of its occurrence, is capable of being mined very economically, but owing to the slight demand for the material little is being put on the market at the present time. With a good demand for the material at from $10 to $12 per ton a number of deposits in this stato could be worked at a profit and a large amount of asbestos could be put on the market.

The Production of Fuller's Earth in the Southern States: E. H. Sellards.

Fuller's earth is a clay which has the property of absorbing basic colors and removing these from solution in animal, vegetable and mineral oils, as well as from water and certain other liquids. In commerce the earth finds its chief use in clarifying oils, although it has in addition a number of minor uses.

Fuller's earth, like other clays, is complex and consists not of a single mineral, but of a variety of minerals, the mineral particles being mixed in different earths in widely different proportions, resulting in a varying chemical and mineralogical composition. The ultimate analysis does not differ materially from that of other clays. The properties of the earth arise apparently from the physical condition of the clay and can be detected only by a filtering test by which its practical utility in clarifying oils is determined. Various other properties are assigned to fuller's earth but all, aside from actual bleaching tests, are so variable or are common to such a variety of clays as to be of only secondary value in identifying fuller's earth.

Fuller's earth is mined chiefly by the open pit method, the overburden being removed and the earth dug by pick and shovel. It is then crushed, dried, ground, bolted and sacked for shipment. That intended for clarifying mineral oils is ground to pass 30–60 or a 60–80 mesh sieve while that intended for clarifying edible oils is usually ground to 100 mesh. The action of fuller's earth in clarifying oils is believed to be due chiefly to colloidal silica present in the clay. It is a notable fact that clays suitable for clarifying mineral oils

are in some cases at least unsuited for use on edible oils and the converse is also true. Most fuller's earth gives a taste and odor to edible oils, but it is now known that this can be removed by blowing dry steam through the refined oil heated above the boiling point of water. Some fuller's earths have so rapid an oxidizing effect on edible oils that the mass takes fire when air is blown through to force out the oil remaining in the earth after treatment. This defect in the earth can not at present be remedied.

In the United States fuller's earth was produced during 1912 by seven states. Of these one, Massachusetts, is an eastern state; two, California and Colorado, are western states; and four, Arkansas, Florida, Georgia and Texas, are southern states. The total output of fuller's earth in the United States during 1912 according to the United States Geological Survey was 32,715 tons, all of which with the exception of one or two thousand tons is from the four southern states named, by far the largest part, probably as much as 25,000 tons, being produced in Florida.

The Clay, Brick, Pottery and Bauxite in Tennessee: WILBUR A. NELSON.

A general account of the clay resources of Tennessee, giving the location of ball-clay deposits in west Tennessee, and some recent tests made by the Tennessee Geological Survey. Also a general account of the brick and pottery industry, and a brief description of the bauxite deposits of east Tennessee.

The Tripoli Deposits of Tennessee: L. G. GLENN.

Extensive deposits of tripoli are found in the Watanga shales of the Cambrian. They are the result of the leaching under surface influences of siliceous-argillaceous limestone beds, one of which is some forty feet thick and of very considerable length. The beds, of which six are known, dip at high angles. The depth to which they have weathered is not determined but is known to exceed fifty feet. The material is very similar to the tripoli now marketed for general scouring and polishing purposes.

The Occurrence, Conservation and Utilization of Certain Non-metallic Minerals of the Southern States: JOSEPH HYDE PRATT.

The Iron Ores of the Southern States: WILLIAM B. PHILLIPS.

The Zinc Deposits of Tennessee: A. H. PURDUE.

This paper gives the location of the zinc ores, extent of their area, occurrence and instructions as to prospecting; gives a brief history of zinc mining in Tennessee, with prominent mention of the old Embreeville mine, and also describes the present mining conditions and output.

The Copper Resources of the Southern States: C. H. GORDON.

This paper is an attempt to present briefly the present condition of our knowledge of the copper resources of the southern states.

Copper minerals are of widespread and general occurrence both in geographic position and in geologic age but the deposits of known age that have made important contributions to the country's output can be referred to four periods which in general correspond to periods of igneous activity, viz., the Precambrian periods, the Paleozoic era, the Mesozoic era and the Tertiary period. The chief Appalachian deposits belong to the Paleozoic era and constitute practically all the known deposits referable to this era.

As to their geologic relations the deposits of the southern states may be classed under four groups as follows: (1) Lenticular deposits in schistose rocks. These include mainly deposits of the sulphides of iron, copper and zinc in lenticular bodies in schistose rocks comprising in part altered sedimentary rocks and in part altered igneous masses of basic and acid types. (2) Deposits in fractured and brecciated zones. Those include deposits in fissure veins and deposits formed in brecciated zones. (3) Deposits of native copper and cuprite disseminated in igneous rocks. Under this head are grouped deposits in which the copper occurs chiefly in the form of cuprite and native copper distributed along joint planes and crevices, and as disseminated grains in igneous rocks of basaltic type. (4) Disseminated deposits in the Red Beds of the Triassic area. These consist for the most part of films and thin coatings of malachite on joint faces and grains of sulphide and phosphate disseminated through the rock.

The chief deposits of the southern states belong to the first and second classes. Ninety-five and one half per cent. of the production of these states comes from the district of Ducktown in Tennessee. Of the remainder over two thirds is recovered as a by-product in the dressing of the lead ores of Missouri.

Physiographic Conditions that have Contributed to the Making of Atlanta: COLLIER COBB.

A Biological and Physiographic Reconnaissance of the Okefenoke Swamp: J. CHESTER BRADLEY. (Illustrated with colored slides.)

The Development of Some Lake Beds in Florida: E. H. Sellards.

This paper relates to the origin of the basins of the large flat-bottomed lakes found throughout certain parts of interior Florida. These lakes are often of considerable size, although relatively shallow as compared to their areal extent. Moreover they are variable in character. Under normal conditions they are clear water lakes abounding in fish and the favorite haunt of the wild duck. They have, as a rule, no surface outlet, yet from many of them the water has at times disappeared in a mannor seemingly inexplicable. Among the largest and best known examples are: Lakes Lamonia, Jackson and Lafayette in Leon county; Miccosukie in Jefferson county; Alligator in Columbia county and Alachua in Alachua county.

These lakes occupy basins which have worked their way down through the surface sands and clays probably of the Alum Bluff formation to or nearly to the underlying limestones which are of either the Chattahoochee or the Vicksburg formations. The beginning of each basin dates from the formation of a sink making an opening through to the underlying limestone, thus diverting the surface drainage to a subterranean course. The small basin resulting from a single sink is enlarged by the formation of additional sinks, this process being promoted by the considerable amount of the surface water that is admitted into the underlying limestone, particularly when the sink has formed in the valley of an existing stream. The depth of the basin is limited by the nnderground water level since the streams can not well carry away the residual material below this level. As a matter of fact the basins approach but do not quite reach the underground water level.

The ground water level is not stationary but is subject to seasonal and periodic variations, as well as to variation in geologic time. The seasonal fluctuation is due to the variation in rainfall during the wet and dry seasons. The periodic variation is due to the more or less regular periods, often of some years duration, of deficient or of excessive rainfall. The gradual lowering of the underground water level during geologic time, which is due to the downward cutting of stream channels which serve as an outlet, affects the life history although not the observed behavior of the lakes. The seemingly sudden emptying of the lakes is in most cases due actually to the water having gradually run out into the underlying limestone because of the ground water level having been lowered by prolonged drought. New sinks are likely also to form at this time since the lowering of the underground water withdraws the support from the surface materials which are then no longer able to support their own weight and hence break through to cavities in the underlying limestone. These new sinks when formed facilitate the emptying of the lakes.

A New Gypsum Deposit in Iowa: George F. Kay.

In this paper some interesting facts are presented with reference to a gypsum deposit recently discovered at Centerville in southern Iowa. The gypsum is of Mississippian age and is associated with anhydrite. Whether or not the gypsum will prove to be of economic importance has yet to be determined. The evidence indicates that the deposit may be extensive and the gypsum is of good quality. The relation of the anhydrite to the gypsum and the relative amounts of the two minerals will have an important bearing upon the value of the deposit for commercial purposes. The fact that the deposit is more than 500 feet below the surface and the presence of large amounts of artesian waters are factors unfavorable to the mining of the gypsum. On the other hand, the deposit is well located with regard to fuel and transportation, and it is fair to assume that if gypsum products were made in this part of the state a good market for such products could soon be developed.

The Development of Some Underground Streams: Edgar H. Webster.

A Comparison of the Ordovician Section of Southwest Virginia, with that of New York: S. L. Powell.

In view of statemonts not infrequently made to the effect that the Ordovician of Virginia and the South in general can not be correlated with the New York section, and in view of the fact that in southwest Virginia, in the vicinity of Salem, there occurs a continuous, unbroken section of Ordovician strata about four thousand feet in vertical thickness, very favorably disposed for observation, and as the locality is intermediate between the extremes heretofore most carefully stndied, detailed work was undertaken for purposes of comparison with the standard sections north.

The results show that the correlation can be made, and that in almost every detail, including the divisions of the Beekmantown (Calciferous) established by Brainerd and Seely of Vermont. Without going into detail here, the main difference

in the Ordovician is at the top and near the bottom of the section. The alternating red and greenish yellow shales and sandstones (Bays) just beneath the Medina sandstone, occupying the position of the Juniata in the north, are here very fossiliferous, whereas in Pennsylvania and New York they are practically barren of life forms. Here it carries Orthoceratites, Gasteropods, Brachiopods, etc., in great abundance. The stratum here measures about eighty feet whereas in the north it is several hundred feet thick. The Hudson River is virtually the same as north. Just above the Trenton, however, occurs a heavy stratum of alternating sandstone and shale, Tellico of the south. The upper Trenton is massive rather impure light blue limestone, passing into thin bedded dark to black limestone with some shales intervening. The middle Trenton is characterized by a development of several hundred feet of black shale (Athens Shale) carrying Trilobites and many forms of Graptolites, among which are the whorled type described by Ruedemann from northeastern New York. This is followed by the Black River limestone, identical in almost every respect, lithologically as well as in fossil content, with that of New York. The same is true for the Birdseye beneath. The Birdseye terminates in a six-foot stratum of brecciated conglomerate, with fragments of limestone and chert ranging in size from one half inch to fifteen inches in diameter. The Chazy, which follows, agrees in its lithology and fossil content with that of Vermont, terminating in a ferruginous sandstone, which corresponds in position and character with the Isle La Motte sandstone.

Detailed work in the Beekmantown below has not as yet been completed, but thus far the divisions established by Brainerd and Seely of Vermont with their characteristic boundaries and fossils are believed to have been identified.

The "Undagraph," Its Use for the Study of Microseisms: OTTO KLOTZ. (Illustrated.)

Recent Backward Extension of the Life Record in Geologic Time: CHARLES KEYES.

The differentiation of life on our globe prior to the stage represented by the *Olenellus*, or Early Cambrian, zone, the oldest phase with which we have been acquainted, has lately passed from the realm of pure speculation to that of direct observation. The wide interest aroused by these recent discoveries of abundant well-preserved organic remains in rocks of undoubted pre-Cambrian, and hence pre-Paleozoic, age is secondary only to the enthusiasm produced a few months ago by the actual location of the fossiliferous horizons in the general geological column. As definitely determined these oldest fossil-bearing levels are stratigraphically more than two miles beneath all other known horizons yielding traces of life. The revelations, of course, materially modify all our previous notions on the subject. They open up a more inviting field of investigation than awaited paleontologists when the Paleozoics first revealed their secrets. Between the bottom of the Paleozoics and the old Azoic gneisses, as usually represented in the text-books of the science, we may now insert the complete schemes of two great fossiliferous successions each of greater stratigraphic and taxonomic importance than that of the entire Paleozoic sequence as now known.

Fauna of the Pleistocene Asphalt Beds at Rancho La Brea, California: J. C. MERRIAM. (Illustrated.)

Tertiary of the Great Basin Region: J. C. MERRIAM.

The Clinton-Niagara Sand Reefs, Dune Ridges and Lagoons—Bordering the Paleozoic Sea: COLLIER COBB.

GEORGE F. KAY,
Secretary

ATLANTA MEETING OF SECTION G

AT 2 P.M., Tuesday, December 30, the meeting of Section G was called to order by the chairman, Professor H. C. Cowles. In the absence of the secretary, Professor W. J. G. Land was made secretary *pro tem.* The following officers were elected. For member of the sectional committee for five years, Dr. D. T. MacDougal; for member of the council, Dr. C. Stuart Gager; for member of the general committee, Professor D. M. Mottier.

The Sectional Committee recommended and the association elected Professor G. P. Clinton, of New Haven, as vice-president and chairman for the Philadelphia meeting.

The following papers were read:

"The Evolution of a Botanical Problem: The Discovery of Sexuality in Plants," address of the retiring Vice-president, Duncan S. Johnson.

"The Water Requirements of Plants," by Lyman J. Briggs and H. L. Shantz.

"Samoan Vegetation," by W. J. G. Land.

W. J. V. OSTERHOUT,
Secretary

SOCIETIES AND ACADEMIES

THE NEW ORLEANS ACADEMY OF SCIENCES

The regular monthly meeting of the Academy was held at Tulane University, on Tuesday, January 20. Dr. Isadore Dyer, the president, presided and there was a large attendance of fellows and members.

The subjects of the meeting were: (1) a paper on "The Passive State of Metals," by Dr. B. P. Caldwell, professor of chemistry at Tnlane. The speaker reviewed the different theories which have been brought forward to account for the facts of passivity from the time of Keir to the present, pointing out the facts in support of, and in opposition to, each theory. He also called attention to certain especially peculiar phenomena attendant upon the processes of passivating and activating, and in closing pointed ont the industrial importance of scientific study of the problem of making iron and metals in general more resistant to corrosion.

The second paper was read by Dr. W. L. Owen, of the United States Bureau of Agriculture, upon the problem of the maintenance of soil fertility. The speaker brought out the fact that the problem seemed much more complex to-day than it did when Liebig made his celebrated contribution to the subject. The problem of the future, according to the speaker, will concern itself more with the detection of soil toxines and the best means of stimnlating the various groups of soil bacteria than in the increased nse of commercial fertilizers.

There was some discussion at the conclusion of these papers, in which Drs. Gustav Mann, C. C. Bass and J. H. Clo and other speakers participated.

R. S. Cocks,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The ninety-fourth regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, February 3, 1914. Messrs. Raymond B. Wilcox, Arno Viehoever and Henry Pittier were elected to membership.

The scientific program was as follows:

Brief notes and Reviews of Literature.

Dr. David Griffiths reviewed a prospectus of a stock company which has been organized in Australia for the purpose of eradicating the cactus, which is there considered a serious pest.

Mr. S. C. Stuntz called attention to the return from Brazil of Mr. A. D. Shamel, who has been there with Messrs. Dorsett and Popenoe, who are studying methods of tropical fruit culture and introducing the varieties that may be of value in this country. Mr. Shamel brought back over 1,100 photographs which have thus far been taken by them, and prints of these will soon be available for study at the Office of Foreign Seed and Plant Introduction for those who are interested.

A Report on the Atlanta Meeting of the Botanical Society of America: Dr. R. H. True.

Dr. True gave a report on the attendance at the meetings and number and character of the papers read before the different sections, with special notes regarding those of a botanical character.

The Relation Between Transpiration and the Absorption of Inorganic Constituents by Plants: Dr. H. Hasselbring.

Published in *Bot. Gaz.*, 57: 72–73, January, 1914.

A Fertile Hybrid Between Tripsacum and Euchlæna: G. N. Collins. (With lantern.)

To be published in the *Journal of the Washington Academy.*

An Attempt at Revegetation on Kodiak Island, Alaska: Dr. Walter H. Evans.

The conditions on Kodiak Island following the eruption of Mt. Katmai in May, 1912, were described and an account was given of experiments in restoring the meadows and pastures of the experiment station on that island.

The level land was covered with the ash, or, more correctly, the débris from the explosion, to a depth of 12 to 14 inches, and practically all vegetation was destroyed. The only natural revegetation was where hummocks of earth brought the original soil nearer the surface or where plants came through cracks that formed in the deposit during the summer season. In these places fireweed, *Epilobium angustifolium*, and Alaskan redtop, *Calamagrostis langsdorfii*, have come up quite abundantly.

In gardens and wherever an especial effort was made to mix the deposit with the underlying soil, better growth was reported than normal, the ash appearing to have been of benefit, probably by reason of the improved physical condition of the soil.

P. L. Ricker,
Corresponding Secretary

SCIENCE

FRIDAY, MARCH 20, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PROVINCIAL UNIVERSITY IN CANADIAN DEVELOPMENT[1]

THE problems involved in the development of Canada are not to be compared with those of any other country in the world. Her remoteness from the center of imperial government and her close social and business association with the friendly neighbor to the south, who of necessity can not understand her relations to the mother country, have not served to disturb her poise.

To develop, round out, fuse and nationalize Britain has taken two thousand years. In the making of that portion of Greater Britain, the Briton, the Pict, the Scot, the Roman, the Saxon, the Jute, the Angle, the Norman and even the Spaniard, since the time of the Armada, have been fused, whilst the Jew has furnished an increasingly important strain for the past thousand years. Nor has Germany failed to make her contribution to our highest social and governmental strata. The facilities, however, for rapid nation-building have increased by leaps and bounds, of which the chief is ease of transport and communication.

In the United States, the world has had the opportunity to see the creation of a nation in a day, where the scores of elements have been garnered in the four corners of the earth from those countries whose centuries of growth have brought overcrowding and in some have given birth to intolerable conditions.

In Canada, the same conditions obtain as are to be encountered in the United States, with the difference, however, that the Anglo-Saxon dominates, British tradi-

[1] An address given on the occasion of the inauguration of the first President of the University of Manitoba, at Winnipeg, on November 19, 1913.

tion governs and her law and rule are paramount. Also inevitably Canada must afford ultimate relief from the overcrowding of her older neighbor.

The problem of Britain, Germany or Japan is quite another story. These nations in their growth, as well as others which can be easily called to mind, are endogenous, that is, in them development proceeds from within. In the United States and Canada and those countries which are being populated more largely by the immigration of other peoples than by that natural increase which depends upon birth rate, there is crying need of certain nation-building mechanisms, whose function shall be to secure rapid fusion of bloods, and formulation of common standards which shall serve to develop a people of the highest type. In Canada, the ideas and ideals are grown from British seed and transplanted to new-world soil but must have engrafted upon them an international viewpoint suited to her many peoples in order that the full fruition of Canadian national efficiency may be her contribution to the empire.

This very difference in population assets, which in Britain are fixed and in Canada fluid, is a very real difficulty, although by no means insuperable.

The diffusion of accurate information from each portion of the empire to every other part will enable each of the dominions to effect sufficient modification in British procedure and viewpoint for local needs, without fear of being regarded either as lacking in loyalty or too widely divergent from tradition. Canada's task is that of constructing a nation almost "while you wait," which must, however, be a part of that *supernation* upon which the sun never sets. Hers is a constructive problem. She builds anew and does not have to dwell in chaos amid the litter of tearing down whilst she rebuilds her whole national fabric. She will therefore do wisely to profit by the experiences of the older nations in order that there may be no need of the uneconomic and tragic task of reconstruction.

In the development of Britain, undoubtedly her peregrinative propensity involved in sea supremacy has been the natural and rational outcome of her geographical position. In this, our parent country affords us the best possible example in the matter of profiting from the experiences of other peoples and the adaptation of their methods to British needs, whilst at the same time she has given to the world British standards of fair play, established justice, and carried law and order into the Seven Seas.

Japan at the present moment is perhaps the most conspicuous example of what a definite coordinated plan of procedure may do in hastening the solution of very real and pressing economic, social and political difficulties, dependent upon increase of population and limited territory. Her sons are models of patriotism in their eager willingness to expatriate themselves for years in order to bring back to Japan those up-to-the-minute scientific and cultural stimuli needed for national metamorphosis. Apparently, she seeks to be the carrying nation of the Pacific, realizing, as Britain did before her, the real power and opportunity which lie in the assumption of such a function.

She is developing an educational system of which her university is an important part. She is training her youth, not only by manning her schools and universities with the best obtainable talent of other countries, but in every land and in almost every university are Japanese who are gladly sacrificing years of their lives in order to bring home what she needs at this critical period. Her amazing success in the

development and maintenance of physical fitness in the avoidance of disease and in the care of her wounded during the Russo-Japanese war startled the world. It is, however, only one of the many examples of the phenomenal advance which has resulted from her most painstaking and patient efforts to carry out, systematically and in detail, a carefully designed and fully matured plan for securing national efficiency.

The value of such a far-sighted nation-wide scheme is to be seen in the present most wonderful economic and social revolution which is being effected in Germany. The careful preparation in advance of a program by which the state recognizes and provides education in all its stages and in all its phases, from the highest cultural development to the most practical industrial training, is to be credited with the marvelous progress of this country.

It does not suffice to leave to private effort and volunteer organization the provision of sources of culture and scientific study which may or may not become *directly* related to the practical upbuilding of a people. If the state assumes any responsibility at all for education, scientific research, investigation, cultural development and art, she should coordinate her various mechanisms, and see that all possible avenues are opened for the *direct* as well as the *indirect* benefit of the whole people.

Great Britain, though somewhat late in recognizing that education is apt to lag behind instead of dominating social and industrial relations, is rapidly establishing provincial universities and agricultural and technical schools which are being extended in scope and increased in number. The prestige of having the finest cultural centers in the world without available channels for conveying direct to all the people the knowledge of the few, was not meeting her needs.

The development of the state university in the United States and its orientation in the educational system of the commonwealth has been the cause of amazement to the whole world, including some of the older seats of learning in that country itself.

Beginning with Ontario, Canada is developing a system of state or provincial universities. She has every reason to feel proud of those provinces which have taken up this logical and natural as also inevitable function, and no university in America, whether supported by state or private endowment, has developed finer standards or achieved more real success than the University of Toronto.

In order to meet her many peculiar conditions, some of which have been already mentioned, Canada must bring to her work all the help which can be afforded by the other nations of the world. She draws her citizens largely from them. Some of these are capable of adding immediately to Canadian cultural and scientific prestige. Many, however, must be regarded simply as raw material, brought to Canada for the purpose of their individual and collective improvement.

To hasten the process of Canadianizing them and to derive the greatest national profit from the best and the worst in the shortest possible time are most important.

If we are not satisfied to wait until the second or third generation for results, we must provide leaders who know conditions in both lands. The best brains of their countries may be used to leaven our land. They and Canada's strongest sons who have been trained in both lands are needed in our universities and schools.

The example of Japan in this matter is worthy of our emulation if we are to take and keep our place with other nations and

bring to the empire what she has a right to expect.

There is no one force which can do more in this important undertaking than the provincial university when properly articulated with the other educational units of each province, if these resulting provincial systems are properly coordinated and organized into a workable national mechanism.

CONSERVATION OF NATIONAL RESOURCES

It is most important that we appreciate our responsibilities for the heritage which has been given us. We must not be intoxicated by the realization of nature's prodigality. In the exuberance of our youth, we must not sow national wild oats for our children and children's children to reap.

We must conserve our national resources intelligently, which means that we must use and not abuse nature's gifts to us. We can well take warning from the experiences of the United States, where it is being found necessary to hold annual conservation congresses, one of which is now in session at Washington, D. C. At this congress, forest conservation will receive first attention, the desire being to specialize on some one phase of the conservation program at each meeting, for the purpose of achieving more lasting results. In the call issued for this congress, the following announcement is made:

> The fifth National Conservation Congress is to be devoted largely to forest conservation, because of the national importance of the subject in its many phases. Public interest is involved, because upon the proper solution of the various problems depends the cost of the wood without which our civilization would decline; the perpetuation of the timber supply; the development of hydro-electric power; the utilization of non-agricultural lands; the availability of water for irrigation; the preservation of forest areas for health and recreation; and many other developments essential alike to every citizen from the lumberman to the man who owns neither a tree nor a foot of land.

The congress will endeavor to diffuse more information and develop better methods for the prevention of forest fires which cause such tremendous loss of life and of property valued at over fifty million dollars annually, and which also damage the soil, the water and the young timber growth. The study of forest insects is important, since they destroy enough timber every year "to finance the construction program of the navy." The relation of floods to forest denudation, which is in part responsible for the disasters of the current year, will be studied.

The need of knowing exact conditions so as to avoid the use each year of three times the annual timber growth is apparent, particularly when we realize that only forty to seventy per cent. of each cut tree is utilized, while fires are destroying annually the equivalent of this growth. The use of preservatives for the treatment of wood with the view of prolonging its life when used in constructive work is important because through it we have promise of reduction in forest consumption and the possibility of increasing supply by utilizing inferior species of woods at present not available. Another object of the congress is to meet the need on the part of the public for a safe national forest policy against which there seems to be strong opposition.

These details are cited, not because they constitute Canada's most important national waste, but because it is the one which at this moment is receiving recognition and study by our neighbors.

The conservation of the soil elements, the utilization and preservation to the people of water powers, mineral wealth and above all, that chiefest national asset, the public health and human vitality, surely constitute a present-day responsibility, if the

Canada of the future is not to curse the Canada of to-day.

Our land is full of opportunity. Our spaces are wide. Citizens of less fortunate countries, which have wasted their opportunities and shirked their responsibilities until too late, have turned their eyes towards Canada.

Canada has a right to expect, both from her own and her foster children, that they shall use but not abuse their unrivaled chances for national and world betterment. We shall be wise if we see and provide in time the proper mechanisms for harmonizing rapid development with proper conservation of resources before we are fighting for the room and the right to breathe by reason of our overcrowding when we should be unable to think clearly and act intelligently and realize too late that in our short-sightedness we have made unwarranted overdrafts on nature's storehouse.

Facilities for rapid transit and free communication have enabled Canada to have at her command, while she yet has room, all the equipment evolved by the older and more crowded nations. Pioneering in the year 1913 is indeed "*pioneering de luxe.*" This, whilst a matter of self-gratulation for increased opportunity, brings also added responsibility to our generation.

The necessity for the provision of national and provincial facilities for seeking out, accumulating, weighing, standardizing, adapting and diffusing knowledge require no argument: in fact, the newer provinces in the middle and far west have already anticipated this need and we are now met to celebrate an important step in the development of our prairie province from whose ample bosom is derived that sustenance upon which so many in this and other lands have come to depend.

The Canadian government has not been blind to the value of such knowledge to the people. The provision of a fund of ten million dollars to be distributed throughout the Dominion for the benefit of agricultural instruction is a splendid national investment. This far-sighted policy under the direction of such wise leaders of Canadian progress as Dr. C. C. James, will bring much that is needed, not alone to the agricultural interests, but to all of us.

SCOPE, VALUE AND COST OF PROVINCIAL UNIVERSITIES

In the consideration of the function and scope of a provincial university, we should carefully consider the end sought, the benefit to be derived, the means available and the cost of installation and operation. At the present day we are not staggered when confronted with the necessity of spending hundreds of millions of dollars on railways, whose construction is necessary to open up new lands. We pledge our own generation and our children to the payment of vast sums for advantages which sometimes remain problematical for years. We see the need for tremendous capital investment in the matter of mines when sometimes many years elapse before production yields satisfactory dividends. The dividends to be paid by our educational system are not all to be expressed in terms of dollars and cents, but they are sufficiently obvious to induce those states which have had most experience to invest more deeply every year.

I had the honor to deliver the second annual opening address before the faculty of science of the University of Manitoba in October, 1907, at which time I spoke upon "State Responsibility in University Education." On that occasion I gave the available figures for capital and maintenance expenditures in certain of the state institutions in the mid-western portion of the United States. At that time, Wisconsin

was spending for all purposes something over one million dollars per annum. Minnesota's outlay for current expense was over $650,000 per annum. Illinois had available considerably over two million dollars for all purposes for the biennial period.

Only six years have elapsed and yet for the current year 1913-14 there is being expended by each of the three state universities—Minnesota, Wisconsin and Illinois—in round numbers, two million dollars per annum for current expenses, which excludes not only building, but equipment outlay. This increase of approximately three hundred per cent. in six years in expenditure undoubtedly would not be made were it not for the fact that those three states are convinced that they are receiving satisfactory dividends on those combined annual outlays of over six million dollars. That they are being repaid in many more directions than they realize during those early years seems likely, because in the modern university, as in a railroad or other important public utility, the initial cost of installation and operation, as also of extension, must inevitably be very much higher in relation to efficient service than in later years.

For the proper fulfillment of her function of developing leadership in every phase of social and economic development, the provincial university must of necessity keep pace with all human knowledge and add her share to the sum total. When we remember the additions which have been made to our armamentarium in our own generation, we shall be prepared to plan generously for the future.

It requires no mental effort, however, to understand that in order to prepare as well the youth of to-day to meet his responsibility as we were prepared to meet ours, a greater range of teaching and experience must be provided because of the added knowledge of one generation.

The standpoint of the youth of to-day is not very different from that of our own. He believes that his capacity is greater and his viewpoint wider than those of the preceding generation, just as we unblushingly admitted our superiority over our predecessors. Even admitting his increased mentality for the sake of argument, we realize that the youth of to-day can not avail himself of all of our sources of information as well as those which have been discovered since his time. Notwithstanding the increase of human longevity, we are not yet warranted in insisting that thirty or more years be expended in preparation for an active working period of a like term.

Nevertheless, universities must maintain all the departments of real knowledge which were available to earlier generations whilst developing those of importance to the present and coming generation. If she is to be the chief mechanism for the diffusion of knowledge, she must be the leading explorer in unknown fields in order that our stock of knowledge be increased. Upon her rests the responsibility for finding out and bringing over from older and other lands, all that is worth while. She, too, must take a leading place in the investigation of local resources and develop methods for their more intelligent utilization. Thus each province will come to know the resources of other lands and of other provinces and at the same time be in a position to afford exact information and the best possible service to others who need what she has to give.

Canada needs experts in special lines, some of which deserve mention.

HOUSEHOLD ADMINISTRATION, HOME ECONOMICS AND DOMESTIC SCIENCE

These are terms with which we are all familiar and indicate that this generation is waking up to the need of special train-

ing for the most important work in nation-building. The successful making and keeping of the home is indeed a profession which requires the most careful training of women of the best moral fiber and the highest mental equipment. The housekeepers of our land are those who perhaps spend the bulk of the nation's money. Yet in the past there has been little in the way of careful training for this most important economic work. The home-keeper is not less important in our social development. We leave to our women very many nondescript duties included in the care of the home. She it is who knows all details of the children's physical and intellectual progress. She has accurate information about our schools. To her we turn when problems of civic house-cleaning and housekeeping arise through man's negligence. It is, therefore, most appropriate that at length we are providing practical as well as cultural training in order to enable woman to meet some of her obligations.

Universities must train our leaders in women's work and provide facilities for research in the science of home-making and the art of housekeeping, if the word "*home*" is to remain current in the Canadian vocabulary, and this most important phase of our national life is to keep abreast of commercial and industrial progress.

AGRICULTURE

In agriculture we have many problems which are of tremendous importance and interest. The fascination of studies which may lead to the growth of two stalks of wheat where one grew before, of a head which has a double number of grains of the same size, or the same number of grains of double size or a strain which improves quality without impairing quantity, or is adapted to land which was formerly unprofitable or useless, can not fail to arouse national and even international interest since it concerns the food supply of the world. Such studies as those which resulted in the production of the Marquis wheat in Canada, or the work of Hayes in Minnesota wheats, or of Zavitz of Guelph on barleys, have meant millions upon millions of dollars to the new world and food for the nations. The expeditions to Asia of Hensen, of South Dakota, in the search for, and development of, alfalfa suited to cold winters and dry summers brought about an economic revolution and furnished a story as fascinating as is to be found in literature. Babcock and Russell have added millions annually to Wisconsin's assets through their contributions to the making of cheese, butter and other milk staples.

However, these are only a few of the rural problems where scientific, patient work, and wide propaganda are needed. Humanity is traveling cityward and the best of our peoples must have their faces turned again to the country, if we are not to suffer disaster. This means that rural life must be made possible. It must become a life and cease to be an existence. Toward this end every influence in our provinces and in our land must be brought to bear, but it is quite as much a social as an economic question. It includes cultural and artistic phases quite as much as scientific agriculture and the food supply. It also must not lose sight of rural hygiene.

In our land we have many problems which relate indirectly to the soil, and we realize at once that we must develop agriculture as a profession comparable in all respects to other professions. For this work, undoubtedly, we must also develop an artisan class with industrial training just as we must take pains to foster the teaching of other trades and callings.

It is to be hoped that all our universi-

ties will bring every influence to bear to establish anew the dignity of labor. It must be confessed at the present time that Canadians, like Americans, are abandoning manual work as fast as they can to newcomers from Europe and Asia. Either the creation of a peasant class must be squarely faced at this time or the dignity and the vital need of labor must be duly impressed on Canada's native sons. We must return to the ways of our fathers. We must all work if we would be strong, and we must be strong if we would work.

FORESTRY AND FOREST ENGINEERING

The need for the study of forestry and of horticulture is becoming better recognized. Wisconsin has a forest-products laboratory built by the federal government and maintained by the state university, in which such problems as those which are now engaging the attention of the Fifth National Conservation Congress are studied. Every one interested in agriculture needs to know about shelter belts, the care of fruit trees and kindred subjects. Not only for forestry in relation to agriculture but for forest engineers there is an increasing demand. In such countries as British Columbia, the provincial government needs them for the proper conservation and intelligent use of its forest resources, and the Dominion government for its large timber holdings, whilst the transcontinental railways have in their possession vast forest tracts.

The important corporations whose operations are extensive in lumbering industries will need men who are trained in botany, animal biology, chemistry, physics, mathematics, engineering, economics and commerce, in order that they may fulfil those functions which they may reasonably be called upon to perform.

ENGINEERING, ARCHITECTURE, MINING AND COMMERCE

In Canada pioneering has spelled engineering. We lay out and build roads and railroads, construct bridges, tunnel mountains, discover, measure and harness water powers, prospect for and produce from mines, and in every way possible explore and develop our country, realizing at the same time that as yet we have not well begun. We have to develop our resources and facilities for our own use and also in order that we may exchange our commodities with other nations. Chemistry, physics and biology have all to be utilized in our manufacturing processes in increasing degree. Our people have to be housed and so have our industries, we and our products have to be transported. We must fetch to and carry from other nations. Naval architecture and building must be improved even yet. Markets and marketing require most careful investigation and report. Business needs to be put on the plane of a profession and in our universities, pulpits and forums, only one brand of ethics need be taught. The golden rule brought down to date will serve this and many other generations.

For all these activities we must busy ourselves in training men. Our universities need no longer argue the question of whether college men can "make good" in the practical walks of life. The people want more of them. That is why they are providing the provincial and state university with departments, schools and colleges to develop these branches.

LAW

Pioneering is the struggle with nature, the fight with things, the adjustment of the rest of the world to man. As soon as we arrive at the stage when we touch elbows—begin to be "civilized" forsooth—we have

need of the lawyer to help us adjust man's rights to mankind's needs. We do wisely if we train these men carefully who are to compose our difficulties, lest they only stir up strife where they should be strenuous for peace. We expect them to be the leading force in developing society by making the individual conform to the mass. They must therefore be men of the highest integrity and trained most broadly. They need a knowledge of what has gone before. They need all the cultural training available and they most certainly need some information in regard to the sciences if they are to be intelligent in the making and interpretation of laws which are intended to crystallize our most advanced thought and fix common procedure.

The preceptor system is ideal when the student is articled to one who can and will teach and who feels at once his opportunity and his obligation. It is, however, as unreliable as it is antiquated, and is antiquated because it is unreliable. It belongs to the dark ages when public schools and compulsory education were unknown. Whilst medicine has taken many liberties with pedagogical principles, she has long ago given up the apprentice system, and of recent years has introduced modern teaching methods into her schools. Law must inevitably follow. The public will doubtless develop state mechanisms for training our lawyers, who have meant and must continue to mean so much to British progress and national stability. British law is the pride of the empire.

MEDICINE AND ALLIED BRANCHES

The people realize in increasing degree that the provision of better physicians and nurses for their children is the best possible public investment, a form of life insurance that is safer than any other. They understand that it is the people's business to provide adequate training and to insist that those who are to be entrusted with the lives and welfare of our citizens avail themselves of that training and present satisfactory evidence of proper qualification for their work. Medicine is being increasingly socialized. We are drifting perceptibly nearer to the time when the doctor will be a public servant and not a member of a privileged class. It is therefore only just and right that he be trained at public expense. This means provision not only of biological, chemical and physical laboratories, but laboratories of medical science, clinical laboratories, hospitals, dental infirmaries, dispensaries, nurses' homes, and other such facilities, all as a part of the equipment of a provincial university.

The expense of such an undertaking should properly be assessed not alone against the university, however. It is a good public investment when the by-product more than pays the total cost of operation. The teaching hospital, the backbone of such a university school of medicine, by returning to the community from which the patient comes a self-supporting and independent citizen in lieu of a helpless being—a burden to himself and others—is far more than paying the cost of maintenance. In fact, the cost of operating the hospital and its associated laboratories should really be charged not to education, but to public works, not to life insurance for our children, which medical teaching means, but to current provincial business, which increases the earnings of to-day. We are learning to know that in fairness both to the sick who can not work, and to the well who must work, the place for the sick is in the hospital. The sick can not receive such kind and efficient care at home whilst the amateur nursing and household disturbance both interfere with the work and reduce the vitality of the well.

PUBLIC HEALTH AND SANITATION

To provide for medicine is not to meet the needs of public health. Its conservation involves phases of medicine, engineering, law-making and enforcement, sociology, economics, education and many other lines of endeavor. The construction of the Panama Canal, that marvel of engineering, has been possible only because at length man has been able to stay the hand of the grim destroyer. The annual death toll under the De Lesseps regime was one out of each ten. It is now less than one out of each hundred amongst the white employees in the canal zone.

The same forces of nature which science has tamed for man's use and pleasure, the biological and physical sciences, have been applied in the war with disease. Death can be postponed and man's working period lengthened. Man was in sad need of improved weapons for his own defense in view of the rapid multiplication of complexities developed by modern life which masses thousands together in a few minutes and as quickly disperses them. Velocitamania—speed craze—is the microbe's friend, whilst our high tension life gives him the needed hold by increasing vital waste. In turn, hygienic success and extension of man's active period means increased population and adds new problems to the many perplexities of the engineer, the architect, the sociologist, the economist and the statesman. And so we are mutually helpful and mutually harmful.

We have come to recognize that the individual's fitness is not only his prime business but the public's affair as well. In increasing degree are we interfering with personal liberty for the benefit of the race. In line with this tendency we must undoubtedly expect to see colleges and schools of public health, as differentiated from medical schools, developed in our state universities. They can only succeed by enlisting all official and volunteer public health agencies in the training of workers for the many fields in which specialists are required. They involve so much of basic science and culture that they can be developed only in universities and will be most successful in state or provincial or federal universities. The members of the teaching corps are already available if we add the trained workers in official and voluntary public health services, who can furnish the practical work which in the language of the medical school might be termed "public health clinics."

It is time that all those who are charged with responsibility for the care of the public health be trained before they undertake that responsibility rather than to receive their training at the expense of the public welfare. This the public realizes and will demand.

PEDAGOGY

With the advance in professional and industrial education has come a very real need for teachers' colleges which can not be met by our normal school system. Their proper home is in our universities since they require on their staffs the very men there available. They must be taught to know and then to teach. We must teach teachers of domestic science the mechanic arts, agriculture, nursing, personal hygiene and many other lines of work. These embryo teachers must have their practise schools to learn under proper direction the art of teaching. A nice articulation must be made, however, in order to see that in our educational system there is neither uncovered ground nor undue overlap. The need of training drilled public servants available for permanent positions in a stable profession is so overwhelming that there is little present danger of overlap.

THE NEED FOR TRAINING PROFESSIONAL COORDINATORS

Life is a continual fight with physical, biological and social environment. In the struggle man has gradually acquired a composite equipment. As in the process of evolution from single celled organisms to the higher animals there is loss of cell versatility and acquirement of very special function on the part of cells, cell groups and systems, so in the social organism development has come about. We have come far and are going farther towards specialization. Our increase in aggregate knowledge has come by this very specialization, yet whilst this gives each of us more power in his own sphere it makes him increasingly dependent upon others. The more knowledge we acquire in our own field, the less we are apt to have in our neighbor's. Inevitably we shall become incapacitated from over-specialization unless we develop our *"social nervous system"* to a corresponding degree. Our problems become more largely governmental. We need professional coordinators; we require those who can comprehend and compel cooperation. We have come to the point in our development when we must have trained statesmen, publicists, journalists, social experts, public hygienists, lawmakers, and last, but not by any means least, spiritual advisers and leaders. As man gets to know more about himself and his environment, and learns to control in increasing degree the forces of this world, he does not lose interest in the question of whence he came and whither he goes. He needs to be understood and helped whilst here, however. We begin to see more clearly the relation between disease and morality, between poverty and crime and between poverty and sickness. We know that physical efficiency is inexplicably interwoven with mental and moral vigor. We appreciate better each day the unrighteousness of ignorance and of disease, as well as of doing less than one's best.

LITERATURE, THE ARTS AND SCIENCES

Mention of these has been reserved till now because of the obviousness of their place in any scheme of university development. At no very recent date they largely constituted the college and university curricula, with the exception of science, which has only become respectable in Cambridge within a generation and is now being tolerated in Oxford. We can not so well develop agriculture and other industrial activities which involve science and culture independently of them, since their ramifications interdigitate with and involve all our social and economic functions. These interrelations are so self-evident that no argument is needed in support of the claim for increase in efficiency and the decrease in effort and expense which result from a policy which coordinates these branches and provides a system of vital checks and balances. Home management, agriculture, forestry, engineering, architecture, mining, manufacturing and commerce, medicine, law, public health and all such practical workaday phases of our national life are rooted in the arts and sciences. They presuppose the culture of the humanities, a familiarity with the fine arts, a foundation in the life and literature of the past, a knowledge of current events in this and other lands and the possession of linguistic and other such tools. They are the more practical application of biological, physical and social sciences to the betterment of man in order to place him *en rapport* with his environment and adapt his environment to his requirement as well as to adjust the rights and obligation of man to the needs of mankind and the will of his Creator.

To divorce literature, science and the

arts from the crafts, the industries and the professions is unthinkable. The dreamer needs the doer, the artist needs the artisan, the poet needs the planner, the scholar needs the statesman. The man with the telescopic eye, who sees so clearly the things of to-morrow, but trips over the threshold of to-day, needs the social myopic whose condition results from too close and too prolonged contact with the minute work of the world. One warns the other of things to come whilst he in turn is protected against the dim dangers of the day. The so-called practical men need theory, and the theorists need practise. The workers need uplift and the apostles of culture need contact with the earth. The people's university must meet *all* the needs of *all* the people. We must therefore proceed with care to the erection of those workshops where we may design and fashion the tools needed in the building of a nation and from which we can survey and lay out paths of enlightenment, tunnel the mountains of ignorance and bridge the chasms of incompetence. Here we will generate currents of progress and patriotism while we prepare plans and begin the construction of a finer and better social fabric than the world has known. Having done our best to found provincial universities without provincialism, let us pray that posterity may say of us that we builded even better than we knew.

It's the olden lure, the golden lure, it's the lure of the timeless things.

F. F. Wesbrook
The University of British Columbia
November 19, 1913

THE INDIAN LADDER RESERVATION

Geologists in many parts of the world will be interested in the announcement recently made of the gift to the state of New York as a public park of the "Indian Ladder" and its adjoining portions of the Helderberg mountains escarpment in Albany county, New York. Next, perhaps, to the Schoharie Valley, the Helderbergs and the Indian Ladder have the most intimate and ancient association with the history of geology in this state and are really a classic ground in American geological science. Interesting not alone for its geology, as the original section of the "Helderberg formation" and its various subdivisions, with their profusion of organic remains, the Indian Ladder is equally commanding as a scenic feature. There is perhaps nothing just like it in origin and effectiveness. From the summit of the long sheer limestone cliff the eye commands the panorama of the conjoined Hudson and Mohawk Valleys picturesquely spread out over a vast area bounded at the north by the foothills of the Adirondacks and at the northeast by the Taconic mountains and the Berkshires. And over this splendid picture generations of geologists have gazed, for the Helderbergs have been the Mecca of geologists for well nigh a century.

The generous gift to the people of New York State comes from Mrs. Emma Treadwell Thacher, widow of the late Hon. John Boyd Thacher, a distinguished statesman, historian and litterateur. Its more than 350 acres extends along the escarpment so far as to include all its most striking portions and the new reservation is essentially a geologic and scenic park. It was the intention of Mr. Thacher that it should have this ultimate disposition. Mr. Thacher, who had a summer home in the Helderbergs, was much in Europe engaged in his historical researches. On one of his returns he told me that he had heard so much of the Helderbergs, their rocks and their fossils, among circles of savants with whom he was thrown that he determined to do his part to preserve this famous cliff from any danger of invasion, because of its natural beauty and extraordinary scientific interest. Impressed by the worth of preserving such natural monuments, Mr. Thacher's high-minded purpose has now been made effective.

John M. Clarke
New York State Museum

THE OHIO STATE BOARD OF HEALTH AND THE OHIO STATE UNIVERSITY

THE first move in the general plan to increase the cooperation of the State Board of Health and the Ohio State University has been to move the offices of the former to Page Hall on the university campus. The laboratories are still located at the Hartman building but as soon as the botany building is vacated and remodeling completed, the laboratories will also be moved to the university. It is the intention of Dr. E. F. McCampbell, secretary and executive officer of the State Board of Health, to increase the facilities for popular education and for the education of health officers along public health lines. The educational facilities possessed by the university will be of great value in furthering this plan.

Dr. R. G. Paterson, formerly secretary of the Ohio Society for the Prevention of Tuberculosis, is now in charge of the division of tuberculosis and public health education in the State Board of Health and it is intended to make use of the university in furthering the work of this division. While it is true that the university will be of value to the State Board of Health, the latter will also be of value to the university.

Dr. Frank G. Boudreau, director of the division of communicable diseases, plans to place at the disposal of qualified medical students the facilities which his division possesses in the investigations and research work carried on by his department.

The secretary, Dr. E. F. McCampbell, who is also director of the hygienic laboratories, plans to begin the manufacture of vaccines and anti-toxins as soon as the laboratories are established at the university. This will be done in connection with the university laboratories and the veterinary department. The public health exhibit of the State Board of Health is now at Coshocton and will show at Uhrichville, East Liverpool, Bellaire, and other points in the northeastern portion of the state in the next two weeks. The exhibit was very successful at Newark and Zanesville and drew large numbers of sightseers daily. A lecture on public health is given each evening by one of the members of the staff of the State Board of Health. This lecture is illustrated with stereopticon slides and is followed by moving picture films on various subjects. The exhibit comprises photos, aphorisms, cartoons and models illustrating the prevention of tuberculosis, occupational diseases, communicable diseases and various phases of sanitary engineering work and other matters pertaining to sanitation. Improvements and new material have been constantly added to the exhibit and it has been modified in accordance with the effect produced upon various communities. The exhibit was shown before the Columbus Academy of Medicine and the conference of the State Board of Health with city health officers in January, 1914.

SCIENTIFIC NOTES AND NEWS

THE committee of the Lister memorial fund has commissioned Sir Thomas Brock, R.A., to execute a medallion portrait of the late Lord Lister, to be placed in Westminster Abbey.

SIR J. J. THOMSON has been elected president of the Physical Society of London.

PROFESSOR ERNST HAECKEL was ennobled on the occasion of his eightieth birthday.

DR. SIMON SCHWENDENER, professor of botany at Berlin, has celebrated his eighty-sixth birthday.

SURGEON-GENERAL GORGAS, on his return from his mission to South Africa, and his two companions, Dr. Darling and Major Noble, will be entertained at a complimentary dinner in London on March 23. The chair will be taken by Sir Thomas Barlow, president of the Royal College of Physicians, who will be supported by Sir Rickman Godlee, president of the Royal College of Surgeons; Sir Francis H. Champneys, president of the Royal Society of Medicine; Sir David Ferrier, president of the Medical Society of London; Sir Havelock Charles, president of the Society of Tropical Medicine and Hygiene; by the regius professors of medicine in Oxford and Cambridge, and by the directors of the medical services of the Royal Army and Navy.

We learn from the *Journal* of the American Medical Association that the Robert Koch Foundation at Berlin for Research on Tuberculosis has granted a subsidy of $500 to Professor Lexer, of Jena, for research on the action of light rays on tuberculosis tissue, and to Professor Kayserling, of Berlin, to carry on his roentgenologic investigation of the distribution and extent of infection in tuberculosis-ridden families.

The National Institute of Social Sciences presented gold medals of the Institute to Dr. Abraham Jacobi and Professor Henry Fairfield Osborn at the New York Academy of Medicine on March 20.

The Council of the Royal Astronomical Society has elected to honorary membership Miss Annie Cannon, of the staff of Harvard College Observatory.

Dr. Barton Warren Evermann has resigned the position of chief of the Alaska Fisheries Service, United States Bureau of Fisheries, and that of curator, division of fishes, United States National Museum, and has accepted the directorship of the museum of the California Academy of Sciences.

Dr. Raymond Foss Bacon has been appointed to succeed the late Dr. Duncan as director of the Mellon Institute for Industrial Research of the University of Pittsburgh. He was formerly associate director of the institute.

Lieut.-Col. Charles F. Mason has been appointed chief health officer of the Canal Zone, and Lieut.-Col. George D. Deshon superintendent of the Ancon Hospital.

Professor C. E.-A. Winslow, of the New York City College and the American Museum of Natural History, has been appointed advisory expert on public health education by the New York State Commission of Health.

Dr. Philip Adolph Kober has resigned as research chemist in the Harriman Research Laboratory of the Roosevelt Hospital, his resignation to take effect at the end of September.

Professor Löhnis, of the laboratory for agricultural bacteriology in the University of Leipzig, has accepted a call to a position in the Department of Agriculture at Washington.

Mr. J. Adams, assistant in botany in the Royal College of Science, Dublin, has been appointed to a position under the Canadian government.

Dr. Hans von Staff, docent for geology at Berlin, has been appointed geologist for German Southwest Africa.

At the recent meeting in Chicago of the Association of Medical Colleges, officers were elected as follows: *President,* Dr. Isadore Dyer, Tulane University; *Vice-president,* Dr. Charles R. Bardeen, University of Wisconsin; *Secretary-treasurer,* Dr. Fred. C. Zapffe, 3431 Lexington Street, Chicago; *Members Executive Council,* Dr. William J. Means, chairman, Ohio State University; Dr. Randolph Winslow, University of Maryland; Dr. Egbert Le Fevre, University and Bellevue Hospital Medical College; Dr. F. C. Waite, Western Reserve University, and Dr. E. P. Lyon, University of Minnesota.

Dr. David Starr Jordan has sailed from Italy for Australia, where he is giving a series of lectures. He will visit Ceylon, where he will make a collection of fishes and later expects to make a study of the results of the war in the Balkan States. He plans to reach California late in August.

President Harry Pratt Judson, of the University of Chicago, will go to China under the auspices of the Rockefeller Foundation of New York to examine and report on the situation there in regard to medicine, surgery and public health. The party will include also a medical expert. They will sail from New York on March 21, proceeding to Paris and thence to Moscow, arriving at Peking on April 19. President Judson will visit the principal places in China where work of the character in question is carried on. During the heat of the summer President and Mrs. Judson expect to spend some time in Japan, and early in the autumn they may go to southern China, sailing from Hongkong for San Francisco and stopping at Honolulu on the way. The investigations in China will occupy six months.

PROFESSOR D. C. MILLER, of the Case School of Applied Sciences, has given two lectures on sound at Cornell University. The first lecture, on "The Science of Musical Sounds," was given under the auspices of the College of Arts and Sciences; the second, on "The Physical Characteristics of Vowels," under the auspices of the Sigma Xi Society.

THE Washington Academy of Sciences held a joint meeting with the Chemical Society of Washington on March 16, when an address on "The Chemistry of Colloids" was given by Dr. Wolfgang Ostwald, of the University of Leipzig.

BEFORE the Geographic Society of Chicago on March 13 a lecture was given by Professor Henry J. Cox, in charge of the Chicago office of the United States Weather Bureau, on "Cranberry Bogs and the Cranberry Industry."

DR. W. W. CROSBY, Baltimore, delivered a lecture on February 28, before the students in highway engineering, Columbia University, on the subject of "Cost Data in Highway Engineering."

IN connection with an arrangement of exchange lectures with the Missouri School of Mines, the University of Kansas, the Iowa State College and the University of Wisconsin, Professor H. H. Stoek, of the department of mining engineering of the University of Illinois, has returned from giving a course of three lectures at Rolla, Missouri, Lawrence, Kansas and Ames, Iowa. The subjects of the lectures were the "Geography, Geology and Properties of Anthracite"; the "Mining and Preparation of Anthracite," and the "Sociological Features of the Anthracite Industry."

UNDER the auspices of the State Water Survey of the University of Illinois, the sixth annual meeting of the Illinois Water Supply Association held a three day's session March 9 to 11 in Urbana. Among the university men giving addresses were Director Edward Bartow, of the State Water Survey; Professor A. M. Talbot; Professor Otto Rahn and Dr. John A. Fairley. The latter spoke on "Public Control of Water Supplies in Illinois." Among the speakers from a distance were Mr. E. M. Chamot, of Cornell University; Mr. Wm. M. Booth, of Syracuse, N. Y.; Mr. Jay Craven, of Indianapolis; Mr. W. M. Cobleigh, of Montana State College, and Dr. A. J. McLaughlin, of Washington, D. C.

DR. EDWARD SINGLETON HOLDEN, astronomer and librarian of the United States Naval Academy, formerly director of the Lick Observatory, died on March 15, aged sixty-eight years.

SIR JOHN MURRAY, the eminent Scottish naturalist and oceanographer, was instantly killed in an automobile accident on March 16. He was born in Canada in 1841.

MR. GEORGE WESTINGHOUSE, the distinguished inventor and engineer, died on March 12, aged sixty-eight years.

DR. THOMAS MORGAN ROTCH, professor of pediatrics in the Harvard Medical School and well known for his publications on the diseases of children, died on March 9, aged sixty-five years.

MISS EDITH ETHEL BARNARD, Ph.D., instructor in chemistry at the University of Chicago, died on March 8.

DR. F. KORTE, a well-known physician of Berlin and father of the distinguished surgeon, has died at the age of ninety-six years.

THE death is also announced of Dr. August Pauly, associate professor of zoology at Munich.

THE U. S. Civil Service Commission announces an examination for assistant explosives engineer, on April 8, 1914, to fill a vacancy in this position in the Bureau of Mines, at Pittsburgh, Pa., or at other places in the field, at salaries ranging from $1,620 to $2,100 a year, and also for an assistant drainage engineer, for both irrigated lands and humid regions, in the Office of Experiment Stations, Department of Agriculture, at salaries ranging from $1,000 to $1,500.

WE learn from *Nature* that by the will of the late Alderman H. Harrison, Blackburn, legacies amounting to £82,600 are bequeathed to public objects, among which are: £1,000 each to the Imperial Cancer Research Fund,

the Cancer Investigation Department of the Middlesex Hospital, and the Cancer Hospital for cancer investigation; £5,000 to Manchester University for general purposes, and £1,000 for the Chinese chair; £2,000 to Blackburn Grammar School for playfields, and £1,000 for university scholarships.

About thirty pictures of psychologists have been secured and reproduced for distribution by Professor E. A. Kirkpatrick, of Fitchburg, Mass., in accordance with the plan outlined in this journal some months ago.

Arrangements are in progress for a Meteorological Congress to be held in Venice in September and to which meteorologists of all countries are to be invited.

The Pasteur Institute of Paris has invited directors of similar institutes and antirabic services throughout the world to a conference on hydrophobia with special reference to etiology, prophylaxis, treatment and statistics. The conference will meet in the Pasteur Institute April 7 to 10, 1915.

Nature reports that the London School of Tropical Medicine has sent an expedition to China to study the mode of dissemination of human diseases caused by trematode parasites, especially bilharziosis, and the relation of such diseases to those occurring in domestic animals. Investigations into ankylostomiasis will also be carried on. The members of the expedition are Dr. R. T. Leiper, helminthologist of the Tropical School; Surgeon E. L. Atkinson, R.N., and Mr. Cherry-Garrard. The two last named were members of Scott's Antarctic Expedition, and the name of Surgeon Atkinson is familiar to the public as the leader of the search party which recovered the bodies of Capt. Scott and his companions.

UNIVERSITY AND EDUCATIONAL NEWS

An anonymous gift of $20,000 has been made to the library of Haverford College. The interest is to be used for the purchase of books on literature, history and art.

At the meeting of the Council on Medical Education of the American Medical Association, held in Chicago on February 24, the following colleges were given higher ratings: The University of Pittsburgh, School of Medicine; Jefferson Medical College, and the Starling-Ohio Medical College (now the College of Medicine of the Ohio State University) were raised from Class A to Class A+. The Atlanta Medical College, Atlanta, Ga., and the Fordham University School of Medicine, New York City, were raised from Class B to Class A.

At the regular meeting of the board of trustees of the University of Pennsylvania held March 9, it was decided that beginning with the session 1914–1915, all candidates for the degree doctor of public hygiene shall be required to have had identically the same preliminary education as that now demanded of those entering upon medical courses leading to the degree, doctor of medicine; that is to say, at least two years of college work plus the specified amount of physics, chemistry and biology as set forth in the University of Pennsylvania catalogue.

At Columbia University the following assistant professors have been promoted to the grade of associate professor, from July 1, 1914: Charles P. Berkey (geology); Bergen Davis (physics), and James H. McGregor (zoology). Instructors promoted to be assistant professors are as follows: Jean Broadhurst (biology—Teachers College); Clifford D. Carpenter (chemistry—Teachers College); Harold B. Keyes (physical education—Teachers College); Arthur C. Neish (chemistry); John M. Nelson (chemistry); Edward D. Thurston, Jr. (mechanical engineering); Harold W. Webb (physics); Mary T. Whitley (educational psychology—Teachers College), and Jesse F. Williams (physical education—Teachers College).

William J. Miller, Ph.D., professor of geology for the past nine years at Hamilton College, has been elected professor of geology at Smith College.

Mr. J. M. Wordie has been appointed demonstrator of petrology at the University of Cambridge.

DR. OTTO KLEMM, docent at Leipzig, has been appointed professor of psychology in Alberta University, Edmonton, Canada.

DR. KARL HESCHELER has been appointed professor of zoology and anatomy at Zurich, to succeed Professor A. Lang, who retires from active service.

PROFESSOR ALBERT BUSHNELL HART has been selected by the German government as Harvard exchange professor at the University of Berlin for the academic year 1914–15.

DISCUSSION AND CORRESPONDENCE

THE RELATIVE IMPORTANCE OF SULPHATES AND PHOSPHATES IN SOILS

IT has been demonstrated by a number of investigators[1] that the total sulphur content of soils is generally low, the amount usually not exceeding 1,000 pounds in an acre surface foot. Further, it has been shown that an equal mass of soil will contain quite as much and very often a greater quantity of phosphorus. Another fact of equal importance and which has been abundantly demonstrated is that the demands for sulphur by farm crops is not appreciably less than for phosphorus.

No one familiar with this subject would question the necessity of maintaining the supply of phosphorus in a soil, but only lately has attention been focused on the sulphur problem, placing that element in the same category with phosphorus as an element of low supply and an economic factor in crop production and permanent fertility.

On the basis of "total" analysis it appears certain that the amount of sulphur in our common soils is not larger than the phosphorus supply, and, further, that the amount brought to the surface annually in the rainfall will not compensate for the loss the land sustains by drainage.

Yet when we admit these facts we have only opened the problem of the necessity of sulphur fertilization. It is becoming rather common practise to attach a great deal of importance to the total quantity of any given essential plant food element in the soil, believing that this alone will measure or determine the permanent crop-yielding power of a given soil. For a measure of permanent crop production and for the knowledge upon which to build the soil to a certain plane of efficiency these determinations undoubtedly have value, but in the problem of continued fertilization too often we lose sight of the influence of the added material on the biological soil processes and the physiological balance of nutrients essential for the optimum growth of plants.

[1] Bogdanoff, Abstract Expt. Station Rec., 11, 723; Dymond, Hughes and Dupe, *Jr. Agr. Sci.*, 1905, 1–107; Hart and Peterson, Research Bull. No. 14, Wis. Exp. Station; Shedd, Bull. No. 174, Ky. Agr. Expt. Station.

While it is admitted that the soil supply of sulphur is as low as the phosphorus supply, yet the question must be raised and answered—will sulphates influence crop production to the same extent as added phosphates?

It is apparent that part of the soil sulphur is in organic forms and part as sulphates, but that the organic forms are constantly being oxidized to sulphates. The additional fact that drainage waters are richer in sulphates than in phosphates must lead to the conclusion that the solubility of the sulphates in the soil water is much greater than the solubility of the phosphates. This being true, it is apparent that a lesser total quantity of sulphates in a soil would be as efficient in maintaining a sufficient sulphate concentration in the feeding zone of the plant as a much greater total quantity of phosphates.

In addition to the question of solubilities the important factor of the relative effects of sulphates and phosphates on the biochemical soil processes must be raised. Such important biochemical processes as ammonification, nitrification, nitrogen fixation, and the rate of decomposition of organic matter with its accompanying liberation of carbon dioxide can not be too greatly emphasized in deciding on the relative fertility of soils.

It has been demonstrated beyond question in certain phases of fermentology that cellular and enzymatic activities are markedly increased by the presence of soluble phosphates. Harden and Young have shown that the ac-

tivity of the yeast cell or its zymase is greatly accelerated by the presence of these substances. The question then may properly be asked whether soluble phosphates do or do not accelerate the activity of the organisms or the enzymes responsible for those important soil processes mentioned above, and further whether sulphates effect in the same degree such accelerations.

Work in this and other laboratories has progressed far enough to indicate that soluble phosphates have a very material effect in increasing the number and consequently the rate of ammonification, nitrification, nitrogen fixation, and carbon dioxide output of those soil organisms capable of carrying out these processes, while sulphates do not, at least in the same degree, accelerate their multiplication. My thanks are due Professor C. Hoffmann for conducting such experiments.

From such results it is evident that sulphates will not be of the same importance in increasing crop production as can be expected from the phosphates. An adequate supply of sulphates is, of course, necessary, and for those crops making an abundant use of sulphur, such as the high protein plants and the members of the Cruciferæ, a further concentration in sulphates of the soil water may often result in increased crop production. But to the phosphates must be ascribed functions additional to that of merely maintaining a certain concentration of phosphorus in the soil solution—namely, the important function of greatly accelerating the biological activities of the soil.

In conclusion, however, it should be emphasized that as crop production per unit of area increases through the extended use of added phosphorus and attention to proper soil reaction, there will result an increased demand for sulphur.

E. B. Hart
University of Wisconsin

GRIZZLY BEARS: SKULLS WANTED

Half a century ago a considerable number of wholly distinct species of grizzly bears inhabited the western part of North America. They ranged from the eastern edge of the Great Plains in Manitoba and the Dakotas westerly to the Pacific coast in British Columbia and California, and from the shores of the Arctic ocean south into Mexico. The species inhabiting Alaska and the western provinces of Canada, though reduced in numbers, may still be counted among the living, but those of the western United States are with few exceptions extinct; and what is still worse, in most cases only a few skulls remain to afford future students a fragmentary and imperfect picture of the great carnivores which not long ago were dominant figures in our wild life.

For twenty-three years I have been engaged in a study of the bears, and have been favored with specimens (mainly skulls) from nearly all the museums and private collections of the United States and Canada. Still, owing to wide gaps in this material, many questions have arisen which can not be answered. Not only is it impossible to map the ranges of the different species with anything like precision, but in some cases, owing to the absence of skulls of adult males, the characters which serve to distinguish one species from another can be determined only in part.

Therefore, in the hope of obtaining more light on some of these questions before going to press, I wish to make a final appeal to all who have skulls of grizzlies in their possession. I am anxious to see as many skulls as possible of both sexes from all parts of the western United States, British Columbia, Alberta, Manitoba, Yukon Territory and Alaska, and would like to purchase or borrow all that I have not already seen. Owners of skulls will confer a favor by addressing

C. Hart Merriam
National Museum,
Washington, D. C.

QUOTATIONS

THE PARTICIPATION OF UNIVERSITY PROFESSORS IN POLITICS[1]

My dear President McVey: I regret to advise you that I find myself out of harmony

[1] Correspondence between the professor of law and the president of the University of North Dakota.

with the university administration on the question of academic freedom, which I regard as fundamental; and I therefore tender my resignation as professor of law, to become effective at the end of the present academic year, that is to say, in June, 1914.

When I joined the faculty here a year ago last September, it never occurred to me that restraints would be imposed upon my freedom of action in public affairs. Indeed, it was represented that public life presented an attractive avenue to the professor in North Dakota.

Last year I made several speeches during the presidential campaign and induced two of my colleagues to do likewise. After the election, much to my surprise and chagrin, you objected to what we had done. In the interview that you granted my associates and myself, you first took the position that members of the faculty must not take part in national and state politics, although they might participate in municipal politics. I suggested that my resignation was ready, if you spoke advisedly. You asked me not to resign. The interview was terminated with the understanding that you personally were opposed to professors having anything to do with politics, except municipal, but left it to each man to determine his own course.

In October of the present year, at the request of the local leaders, I attended a statewide Progressive conference at Fargo. The gathering was informal, not open to the public, and for purpose of organization. A few days after the meeting, I was advised by the dean of the law school that you had told him that Judge Young, one of the university trustees, had objected to my participation in the conference, taking the position that members of the faculty must keep out of politics, on penalty of dismissal. I was further informed that his position represented the policy of the administration and this has since been confirmed.

It scarcely is necessary for me to observe that I regard such a policy unjust to the faculty and the institution; and I am satisfied that a professor could not legally be removed for exercising the prerogative of citizenship. Under the circumstances, if I were to remain here, I should be compelled either to engage in an unseemly and distasteful wrangle with the administration or to sacrifice the rights and be recreant to the duties of citizenship. Neither course commends itself to me.

In my humble judgment, it will be a sorry day for American education, if the policy of suppression adopted here ever becomes general. One can not, it seems to me, reach his full development, either as a teacher, a citizen or a man, unless he retains normal relations with life. Without this a university professor, no matter how strong his intellect or profound his learning, must become—like the image of Nebuchadnezzar—possessed of a gold head, but feet of clay.

As a last word, may I say that my disposition toward you personally is cordial, and I do not hold you responsible for the policy with which I take issue so squarely. I respect your scholarship and your talent as an administrator, and trust that our relations may remain friendly. All of which is respectfully submitted. Sincerely yours,

Joseph L. Lewinsohn

My dear Professor Lewinsohn: I have your letter in which you indicate your intention of resigning at the end of the year. I shall present the resignation to the board of trustees at their next meeting for their action. I respect your point of view, though I do not agree with it, and wish you to understand that there is no personal feeling in the matter, so far as I am concerned, and that our relations will remain cordial.

I wish, however, to say that in my opinion you are wrong. We have been insisting for some time the judges of the court shall remain out of politics and have put them upon nonpartisan tickets, and it is no longer good form for a judge to take the stump in a political election. To my mind, a professor in a state university occupies much the same position. with even more emphasis upon the necessity of his remaining in a judicial position than in the case of a judge of the state court. I do not want my boy taught political economy, for instance, with a Democratic or Republican

bias, and just as soon as I enter politics I begin to act as a partisan and I lose my place as a judge and an unbiased individual. As soon as a professor enters politics he makes the university an object of political purpose. This is so for the reason that the political activity may be utilized and places gained through political control.

As politics go, you can not escape their consequences, and to develop a theory about academic freedom that you can escape them, and still take part in them, is entirely beside the mark. There is no restriction placed upon the teaching of a professor, or upon his speaking upon social and economic questions, but as soon as he allies himself with a political body which seeks to control the political power of the state, there is danger. The life of the universities in this state and elsewhere depends upon their being able to keep above this kind of politics, the kind that you want to engage in. Professor Ross, of the University of Wisconsin, put it in this way: "We (meaning professors) ought to be willing to give over the forum to the politicians for a period of six weeks, when we have it all the rest of the year."

I do not acquiesce at all in your view that the educational life of the universities and of the state is endangered by this attitude. To my mind, it is good sense and good policy.

With best wishes for your success, I remain,

Yours very truly,

FRANK L. MCVEY,
President

SCIENTIFIC BOOKS

Objektive Psychologie. By W. VON BECHTEREW. Authorized translation. Leipzig and Berlin: Teubner. 1913. Pp. viii + 468. 16 Mks. unbound, 18 Mks. bound.

The study of animal behavior is developing a tendency among certain psychologists to emphasize motor expression as a research method in human psychology. Professor Max Meyer's "Laws of Human Behavior" is typical of this trend, though it shows the influence of traditional psychology in many respects. Other American writers are leaning in the same direction, and Professor J. B. Watson has recently thrown down the gauntlet by proclaiming boldly that behavior is the one fruitful method of psychological investigation, and that the study of consciousness is unscientific and barren.

In his "Objective Psychology" Professor Bechterew attempts a systematic development of psychology according to the behavior method. He does not expressly reject introspective psychology, but proposes to eliminate it from the present work. Starting with the concept of the neuropsychic reflex he aims to describe the whole mental life of man in terms of expression, discarding entirely conscious phenomena, such as sensation, feeling and thought. He calls this science objective psychology or psychoreflexology. A better English equivalent is behaviorism or behavior psychology. Considering the newness of the field, Bechterew's attempt is fairly successful. He has outlined systematically and with remarkable completeness the various aspects of human mental life as they are manifested in every sort of objective expression.

A distinction is made at the outset between purely nervous processes and neuropsychic processes. The former depend solely on present stimuli and inherited nervous mechanisms; the latter are modified by past individual experience (pp. 16, 22, 24). Every impression "leaves in the nerve centers a certain trace which under certain circumstances can be reexperienced and thereupon appears as an associative or psychic reflex" (105). Impressions or stimuli are classed as external (that is, from peripheral sense organs) and internal (organic, etc.); the resulting expressions are either movements, vasomotor activity, or secretion (164). Responses to external stimuli are termed reflexes, those due to internal stimulation are called automatic movements (165), though the distinction is not always sharply marked (166).

Reactions of every type have become organized into complex "acts" by means of special nervous mechanisms aided by the traces of former impressions. Thus an external stimulus may give rise to a complex act such as

walking, through the association of a series of movements whose stimuli have previously accompanied the same stimulus (180). In the formation of such associations inhibition plays an important rôle. Bechterew defines instinct as a complex movement or act which follows *internal* stimulation and results in satisfying some organic need or protecting the organism from harmful or disturbing influences (188). In contrast with instinct, imitation and the circular reflex are based on associations which modify the responses to *external* stimuli.

The complex reflexes which involve association find expression in all three motor modes (movement, vasomotor activity and secretion) and may be investigated in several ways. The author prefers his own method, that of motor association reflexes, to Pawlow's salivary method (262). Considerable space is devoted to an analysis of emotional expression, which he calls mimicry. Bechterew holds that these reflexes have more than a phylogenetic value; they perform an important function in the given reaction itself (327).

The last part of the book examines three specialized forms of complex response, the concentration reflex, symbolic reflex and personal reflex. The concentration reflex is the behavior analogue of attention, and one has no difficulty in identifying the symbolic reflex with language. The discussion of vocal language is thorough, but the treatment of gesture and writing is disappointingly brief. One is surprised that the analysis of sensation and perception, or rather sensory and discriminatory responses, is taken up in connection with symbolic reflexes. It is true that sensation as such can not be brought into the behavior psychology. It can only be investigated by means of responses on the part of an observed organism; and the quantitative measure of sensation in man according to our classic laboratory methods usually involves verbal reactions. Nevertheless this holding back of the discussion of elementary phenomena in a systematic treatise will strike most psychologists as a defect in the objective method itself. It is but fair, however, to point out that the introspective psychology of our fathers relegated elementary *motor* phenomena to the footman's seat in much the same way.

The analysis of personality from an objective standpoint will arouse special interest and is likely to become the focus of criticism. Bechterew holds that "the personal sphere represents the totality of traces from organic associative reflexes, around which a part of the reflexes aroused by external stimuli group themselves by association" (431). These organic traces are experienced in connection with every change of general bodily condition; their sum total forms the "inner kernel of the Neuropsyche" (432).

"Personal reactions are termed *acts* and *deeds*" (435). They are distinguished from other reactions, not by the character of the external stimuli, but by the relation of the present stimuli to the individual's past history. The hunter is aroused to action by the flight of a game bird, which is quite unnoticed by the man with no sporting proclivities. The same stimulus may even affect the same individual differently at different times. Personality in this objective sense guides all our lower activities. Concentration (attention) and the selection of association traces are thus in part determined internally; this is Bechterew's substitute for the free-will experience of subjective psychology. Of interest is his application of muscular work and fatigue to the investigation of personality. Believing that muscular fatigue is due to impairment of both muscle and nerve centers, Bechterew considers that the ergographic curve furnishes a measure of individual efficiency. It is to be regretted that the analysis of personality is not so detailed as the rest of the work.

Bechterew's book is the most consistent attempt at a thorough-going objective psychology so far made. It may be questioned, however, whether he has succeeded in banishing subjective psychology altogether from his pages. In many places affective and emotional terms are used to characterize the basis of reaction. This is especially noticeable in his analysis of hedonic states (107–123), internal reflexes (171–175), and emotional expression

(278 ff.). To be sure these terms are usually set off in quotation marks like the pseudonyms of notorious criminals. In many cases it is only fair to interpret them as a shorthand symbol for a physiological condition. But it does not seem legitimate to distinguish between various sorts of reaction on the basis of subjective conceptions (such as joy and sadness, p. 60, anxiety, dissatisfaction, etc., p. 111) unless some clear physiological differentiæ of these hedonic states have first been determined. This the author often neglects to do. He gives physiological *descriptions* rather than physiological *definitions* of these terms; even when he substitutes the terms *sthenic* and *asthenic* for pleasure and pain his criterion is apparently subjective. It is scarcely fair to repudiate subjective psychology, and at the same time to employ subjective hedonic data to differentiate between various modes of reaction.

The book needs considerable condensation. Too much space is devoted to details of particular laboratory experiments, which could be summed up in a few sentences with proper references. The German translation is satisfactory except in the transliteration of proper names from the Russian alphabet. The names of several well-known writers are inexcusably misspelled; for example, Dadge (for Dodge), Fallerton (Fullerton), Merrillier (Mariller), Burdon (Bourdon) and Hawding (Höffding). In one place the values of the time threshold are given in seconds instead of thousandths (422).

It is clearly too soon to attempt an estimate of such a new departure from beaten paths as this work affords. The contemporary "subjective" psychologist of whatever type is not yet sufficiently grounded in behaviorism to evaluate its merits. But however critical of the objective standpoint the reader may be, he will find Bechterew's book worth a very careful study. HOWARD C. WARREN

PRINCETON UNIVERSITY

The Fisheries of the Province of Quebec. Part 1. Historical Introduction. By E. T. D. CHAMBERS. (Published by the Department of Colonization, Mines and Fisheries of the Province of Quebec.)

To any one interested in the history of Canada and the historical development of what was its first and long its chief industry (and would be still were it not for the demand of the newspapers on the Canadian forests), Mr. Chambers's work is fascinating. The author has brought together, from whatever source and with infinite pains, abundant excerpts from ancient relations, with ancient illustrations and contemporary portraiture bearing upon the historic pursuit of the cod and its confreres in the Quebec waters. The golden cod on the Boston State House emblazons a fact that is easily and rather wittingly forgotten: that the *Mayflower* colonists and their successors came to that rock-bound coast to worship God in their own way; but "So God have my soul," said the High and Mighty Prince James, when the Leyden agents of the Puritans told him they were to go to "Virginia" for the *fishing*, "'tis an honest trade; 'twas the Apostles' own calling." So they came to fish for cod as well as to worship in their chosen way, while the sturdy Bretons and Normans who had reached the Quebec coast long years before came simply to fish for cod.

There is romance of history in the Quebec fishing, for it is "more than four hundred years since Basque and Breton fishermen gathered the first harvest of the sea from the waters that wash the coasts of Labrador and Gaspé." Cartier, penetrating the straits of Belleisle into the Gulf in 1534, met a Norman fisher; and after his day, as soon as the wealth of the new French waters became known at home, the men of St. Malo, Honfleur and the Biscayan ports flocked to these shores in great numbers. Even after the conquest the Quebec fishing remained French; while the fishing masters came out from the Channel islands and their descendants to-day still control the industry.

In giving the descriptive records of ancient procedures, Mr. Chambers has assembled a really large part of the active industrial history of maritime Quebec during its romantic

period, for history was in the making in these turbulent waters and along these sequestered shores long before the Gloucesterman was conceived. The purpose of this notice is not to direct attention to the scientific analysis of the fishing business, into which it does not purport to enter, but to applaud the worth and fitness of this contribution to the historic development of the oldest known industry on the North American continent and to congratulate the author on the attractive manner in which he has presented his subject. As an official document it bears the cachet of dignity and the assurance of durability.

JOHN M. CLARKE

NOTES ON METEOROLOGY AND CLIMATOLOGY

CLIMATOLOGY AT THE ASSOCIATION OF AMERICAN GEOGRAPHERS

AT the tenth annual meeting of the Association of American Geographers at Princeton, N. J., January 1 and 2, 1914, six climatological papers were presented:

The Weather Element in American Climates: R. DEC. WARD.

Since American climates are chiefly made of cyclonic weather, this factor is all-important; the actual conditions affect us and not the averages. Winter is a cyclonically-controlled period—at this time of year practically the whole country is covered with cyclonic paths. In summer, solar control is uppermost, the cyclone paths are in the north and the cyclones weak. Thus cyclone paths migrate with the sun. As the distribution of meteorological elements in a cyclone is different in different parts of the country, Professor Ward is preparing regional cyclonic weather types for the United States.

The Frostless Period in Maryland and Delaware: OLIVER L. FASSIO.

The number of days (average of 20 years) between the last severe frost or freezing temperature in the spring and the first in the fall ranges from 130 days in the west to over 200 days in the immediate vicinity of Chesapeake Bay. For further study of plant growth as related to climatic conditions, phenological observations of similar plants in the same soil (transported) are to be undertaken at many points, each group being visited every 10 or 15 days.

Storm Frequency in the United States and Europe: C. J. KULLMER.

A geographical study of cyclone frequency of the United States 1874 to 1891 and of Europe 1876 to 1891 shows irregular or perhaps periodic latitude variations of cyclone frequency. An attempt was made to correlate these latitudinal changes with the eleven-year periodical latitude change of sun-spot belts. Such changes of cyclone frequency are probably accompanied by rainfall and temperature variations.

The Pleionian Variations of Temperature: HENRY ARCTOWSKI.

Swings of temperature covering a year or more seem to be the result of periodic fluctuations in the solar constant plus variations caused by volcanic dust in the atmosphere. This coincides with the results obtained by Abbot and Fowle and many others.

Climate and Human Efficiency: ELLSWORTH HUNTINGTON.

From a study of the piece-work wages of 270 operatives in some Connecticut factories, 1910–1912, it was found that their maximum efficiency came in December with a secondary maximum in May. The minimum of about 85 per cent. of the maximum came in January and another of about 90 per cent. in August. Highest efficiency usually occurred with out-of-door temperatures near 58° (F.), and with wide variations of temperature from one day to the next. Other meteorological elements considered individually in this connection gave no satisfactory results. Further work will be done to compare mental efficiency with weather.

The Snowfall About the Great Lakes: CHARLES F. BROOKS.

The snowfall in this region is heavy because of much moisture precipitated at low temperatures by the many winter cyclones. On account of the cooling action of land on the prevailing west winds blowing across the lakes, the east shores get more snow than the

west. Ice on the lakes by diminishing evaporation reduces the snowfall of the leeward shores. Thus the heaviest snowfall comes early in winter on the east shores in marked contrast with the late winter maximum on the west shores.

THERMOMETER EXPOSURE

Dr. W. Köppen in the *Meteorologische Zeitschrift*, October and November, 1913,[1] has presented the results of a long study of thermometer exposure in different parts of the world with many shelters. His results are briefly stated below. To determine air temperature the thermometer must be sheltered from radiation but not from the air; the air must not travel far between radiators before reaching the thermometer, and the shelter must have low specific heat and be a poor conductor. The English (Stevenson) shelter in the small form of 1883 fulfills the above stipulations very well. But to eliminate the effect of heating by the sun and excessive cooling at night, a screen is necessary. Dr. Köppen proposes a small and simple screen of grass, rushes, brush or palm leaves to be set over the shelter in such a way as to exclude sunlight when the sun is more than 20 degrees above the horizon. The roof of the shelter should be of this material also. As the small Stevenson shelter is too small for the ordinary thermograph and hygrograph, a combined instrument is suggested instead. Since the English shelter is extensively used, these modifications proposed by Dr. Köppen to obtain strictly comparable temperature data can be made with facility.

CHANGES OF CLIMATE

Professor J. W. Gregory, of Great Britain, presented a paper entitled "Is the Earth Drying Up?" before the Royal Geographical Society, December 8, 1913.[2] Of the three general views in this matter, the first (Prince Kropotkin) maintains that the earth has a general tendency towards drought; the second (Professor Ellsworth Huntington) that while there is this general drying the more important changes are pulsatory, and the third (Mr. R. Thirlmere) that climate varies in cycles of 2,000 years or more and that we are now cooling. Professor Gregory put the evidence from different countries on a map. The result shows probable desiccation in historic times in Central Asia, Arabia, Mexico and South America; but increased rainfall in the United States of America, Greenland, Sweden, Roumania and Nigeria. There seems to have been no appreciable change in Palestine, North Africa, China, Australia and by the Caspian Sea. Thus while there seem to have been local variations there has been probably no general change in climate in the historic past. At any rate, no great universal change could be expected without a considerable change in land and water distribution or of the intensity of solar radiation.

AIR MOVEMENT IN THE CIRRUS LEVEL

The geophysical institute of the University of Leipzig has recently issued a work by Th. Hesselberg, "Die Luftbewegungen im Cirrusniveau."[3] From comparison of the tracks of cyclones and anticyclones with the stream lines shown from cirrus observations, the following results have been obtained. Cyclones and moving anticyclones move in the same directions as the air in the cirrus level over the center. The velocity of movement of cyclones and anticyclones is in the mean 0.2 to 0.4 of the velocity of air in the cirrus level. The relative velocity is smaller the deeper the minimum and the higher the maximum.

Air movement in the cirrus level seems to be controlled by the pressure and temperature conditions on the earth. The more intense the cyclone or anticyclone and the smaller the horizontal temperature gradient the greater is its effect on the currents above. The disturbance which a cyclone makes on the cirrus path

[1] "Einheitliche Thermometeraufstellung für meteorologische Stationen zur Bestimmung der Lufttemperatur und Luftfeuchtigkeit," pp. 474–487, 513–523, 1 plate.

[2] Review by "E. G.," *Nature*, London, December 11, 1913, p. 435.

[3] Second Series, Vol. 2, 78 pp., 48 maps, Leipzig, 1913.

works back onto the track of the cyclone. Thus a cyclone may have loops in its path.

JOURNAL OF THE SCOTTISH METEOROLOGICAL SOCIETY

THE annual volume (Vol. XVI., 3d Series, XXX.) of this society including rainfall returns and meteorology of Scotland for 1912 has recently appeared. There are seven special articles. Agricultural meteorology is touched in three—Dr. W. N. Shaw, "On Seasons and Crops in the East of England" (pp. 179–183), A. Watt, "On the Correlation of Weather and Crops in the East of Scotland" (pp. 184–187), and Dr. H. N. J. Miller, "The Composition of Rain Water Collected in the Hebrides and in Iceland, with Special Reference to the Amount of Nitrogen as Ammonia and as Nitrates" (pp. 141–158). Dr. Shaw has another article, "Upper Air Calculus and the British Soundings during the International Week (May 5–10, 1913)" (pp. 167–178). The other papers are—M. M'C. Fairgrieve, "A Possible Two-hourly Period in the Diurnal Variation of the Barometer" (pp. 158–166), Dr. E. M. Wedderburn, "On the Appearance of the Surface of Freshwater Lochs in Calm Weather" (pp. 189–193), and Dr. G. A. Carse, "Note on Atmospheric Electric Potential Results at Edinburgh during 1912" (pp. 188–189).

NOTES

ON January 1, 1914, the United States Weather Bureau began to issue daily weather maps of the Northern Hemisphere with pressures indicated in millibars and temperatures in Absolute Centigrade degrees. This map is printed on the back of the usual Washington weather map of the United States.

THE Central Meteorological Bureau of France has created a special forecast service for aeronauts.

MR. R. C. MOSSMAN, of the Argentine Weather Service, is acting editor of *Symons's Meteorological Magazine* and director of the British Rainfall Association during the temporary absence of Dr. H. R. Mill on account of ill-health.

THE Italian Meteorological Society will hold an international congress in Venice in September, 1914. The higher atmosphere, climatology, aerology, meteorology and maritime meteorology will receive particular attention.

IN connection with studies of air currents, pilot balloons are used extensively in Germany. Vertical currents are determined by comparing the observed rate of ascent of the balloons with the theoretical. The turbulent meeting planes of opposing vertical currents are usually marked by clouds.[4]

THE daily synchronous weather charts of the southern part of the Southern Hemisphere, October 1, 1901, to March 31, 1904, compiled from the observations of ships and the numerous Antarctic expeditions give the first extensive (though general) information concerning the cyclones of the south temperate and sub-antarctic zones. The paths of these cyclones lie far south, particularly in summer, when they are beyond latitude 60 degrees. The average rate of progression is about 20 kilometers per hour—about the same as ocean cyclones elsewhere.[5]

CHARLES F. BROOKS

HARVARD UNIVERSITY

SPECIAL ARTICLES

THE SYSTEMATIC POSITION OF THE ORGANISM OF THE COMMON POTATO SCAB

SCAB is probably the most widely distributed disease of the potato tuber. We are indebted to Professor Roland Thaxter for associating a specific organism with the cause of this disease. His description of the morphological and biological characters of this organism are so careful and his substantiation of the same as causal agent, so conclusive, that we are unable to add anything of material importance—at any rate here—from our own study of the organism.

Professor Thaxter named the organism *Oospora scabies*[1] by which "provisional"

[4] Dr. A. Peppler, *Deutsche Luftfahrer Zeitschrift*, November 26, 1913, pp. 578–580.

[5] See *Nature*, London, December 4, 1913, pp. 393–395.

name the disease organism has since been known. "Provisional" because Thaxter himself expresses his doubt as to the correctness of referring the organism to the genius *Oospora*, remarking that the genus *Oospora* as given by Saccardo has no scientific value.

We had occasion to carefully study this organism recently, and from our observations desire to rectify the nomenclature.

From Saccardo's interpretation of the genus *Oospora*, and from its numerous species, we must consider it as a fungus pure and simple, a hyphomycete of the Mucidineæ-Ameroaporæ. The organism of potato scab proves not to be a fungus. It differs in morphological characters considerably from what is our present conception of an *Oospora*. Mr. G. C. Cunningham at the meeting of the American Association for the Advancement of Science in Washington, D. C. (1911), expressed his opinion that the potato-scab organism belongs to the "higher bacteria" and he proposes to place it in the genus *Streptothrix*. We are also inclined to regard it as a Schizomycete of the filamentous kind, belonging to the Chlamydobacteriaceæ. On endeavoring to place the organism in its proper genus, we found ourselves confronted by one of the most perplexing problems of botanical nomenclature, which promises a rich harvest to those who are fond of such study.

At first we considered *Streptothrix* Cohn[2] the correct genus, but found later that Corda[3] in 1839 founded this genus for another hyphomycetous fungus of which *S. fusca* was his species. Hence, according to the Vienna rules, this name was no longer available for another plant genus. Saccardo still considers this name as given by Corda valid, including four species all of which are distinct from our organism. Furthermore, *Streptothrix*, as erroneously used by Cohn, possesses no "sheaths," whereas our organism does, however delicate they may appear.

[1] Ann. Rep. Conn. Exp. Station for 1891, p. 153.

[2] *Beiträge zur Biol. d. Pflanzen*, Heft 3, pp. 186 and 202.

[3] "Prachtflora europ. Schimmelpilze," p. 23.

Other names such as *Cladothrix*, *Nocardia* and *Actinomyces* have also been loosely used for members closely related to the organism of potato scab. *Cladothrix* is out of the question owing to its false branching and ciliate spores.

Actinomyces was established by Harz in 1878[4] and his description undoubtedly shows generic relationship to our organism. Harz describes *A. bovis* as causing "lump jaw" or actinomycosis.

Homer Wright, M.D.,[5] pleads in favor of the name *Actinomyces* for use only in connection with the organism causing actinomycosis, and suggests that all other organisms of this genus should be known as *Nocardia* "because the use of the generic term *Actinomyces* for them logically leads to giving the name actinomycosis to those cases of suppurative processes due to infection with certain members of the group." This point of view is opposed to even the most elementary conception of botanical nomenclature.

Now *Nocardia* is the name at present in use by Saccardo for members of our group of organisms.[6] It was established by Trevisan in 1889; "he considered the generic name *Actinomyces* untenable because the generic name *Actinomyce* (without the terminal 's') was given by Meyen in 1827 to a fungus (*Hydrotremellinæ* (*Carus*)) described by him ('*Actinomyce Horkelii*')."[7] According to Article 57 of the International Rules of Vienna, it is distinctly laid down that two generic names, even though differing by one letter only, are to be regarded as distinct, which applies in this case.

Hence *Nocardia* Trev. is untenable and *Actinomyces* Harz must stand for these organisms. The organism of potato scab properly belongs to this genus; in consequence I feel justified in correcting the nomenclature as follows:

[4] *Jahresb. Münchener Central Tierarzneischule.*

[5] *Journal Med. Res.*, Vol. VIII., May, 1905, No. 4.

[6] Saccardo, "Sylloge, etc." VIII., p. 927.

[7] Linnæa, Vol. 2, pp. 433.

Actinomyces scabies (Thaxter) Guessow = *Oospora scabies*, Thaxter.

At the same time I shall rectify the genus and species as far as given by Saccardo under *Nocardia* as follows:

Actinomyces Harz 1878 = Streptothrix Cohn 1875; Rossi Doria 1891 = Bacterium Afanasiev 1888 = Oospora Sauvageau et Radis 1892; Thaxter 1891 = Discomyces Rivolta 1878; R. Blanchard 1900 = Nocardia de Toni et Trevisan 1889; R. Blanchard 1900 = Actinomyces Gasperini 1894 = Actinomyce Meyen 1827 = Cladothrix Macé 1897.

Actinomyces farcinica (Trev.) Guessow = *Nocardia farcinica* Trev.

Actinomyces bovis (Harz) Guessow = *Nocardia Actinomyces* Trev.

Actinomyces Foersteri (Cohn) Guessow = *Nocardia Foersteri* (Cohn) Trev.

Actinomyces arborescens (Edingt.) Guessow = *Nocardia arborescens* (Edingt.) Trev.

Actinomyces ferruginea (Trev.) Guessow = *Nocardia ferruginea* Trev.

H. T. Güssow

DIVISION OF BOTANY,
EXPERIMENTAL FARMS,
OTTAWA, CANADA

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE Central and Eastern Branches of The American Society of Zoologists met in joint session at the University of Pennsylvania, Philadelphia, December 29, 1913, to January 1, 1914, inclusive, in conjunction with The American Society of Naturalists, The American Society of Anatomists and the Federation of American Societies for Experimental Biology.

At the meeting for business, held during the afternoon of December 30, the following persons were elected to membership in the society:

CENTRAL BRANCH

James Edward Ackert, Kansas State Agricultural College, Manhattan, Kan.
Robert Chambers, University of Cincinnati, Cincinnati, Ohio.
John Morton Elrod, Missoula, Montana.
E. H. Harper, Northwestern University, Evanston, Ill.
Frederick Isely, Central College, Fayette, Mo.
Ruth Marshall, Rockford College, Rockford, Ill.
H. L. Wieman, University of Cincinnati, Cincinnati, Ohio.

EASTERN BRANCH

Gardiner C. Bassett, Carnegie Station for Experimental Evolution, Long Island, N. Y.
Raymond Binford, Guilford College, North Carolina.
Maynie R. Curtis, Agricultural Experiment Station, Orono, Me.
Hubert Dana Goodale, Amherst College, Amherst, Mass.
B. H. Grave, Knox College, Galesburg, Ill.
Emily Ray Gregory, Buchtel College, Akron, Ohio.
Louise Hoyt Gregory, Barnard College, New York.
George Lester Kite, Wistar Institute, Philadelphia.
C. C. Little, Harvard College, Cambridge, Mass.
E. Carlton McDowell, Yale University, New Haven, Conn.
Norman Eugene McIndoo, Bureau of Entomology, Washington.
Edith M. Patch, University of Maine, Orono, Me.
Alice Robertson, Wellesley College, Wellesley, Mass.

The "committee on organization and policy," appointed at the meeting held at Princeton in 1911, submitted its report in the form of a new constitution, the text of which had been printed and distributed to all members of the society several days prior to the meeting. This proposed constitution was considered section by section and, with certain amendments, was unanimously adopted. In its adopted form, it is as follows:

THE AMERICAN SOCIETY OF ZOOLOGISTS' CONSTITUTION

Article I

Name and Object

SEC. 1. The society shall be called the American Society of Zoologists.

SEC. 2. The object of the society shall be the association of workers in the field of zoology for the presentation and discussion of new or important facts and problems in that science and for the adoption of such measures as shall tend to the advancement of zoological investigation in this country.

Article II

Membership

SEC. 1. Members of the society shall be elected from persons who are active workers in the field of zoology and who have contributed to the advancement of that science.

SEC. 2. Election to membership in the society shall be upon recommendation of the executive committee.

SEC. 3. Each member shall pay to the treasurer an annual assessment as determined by the society. This assessment shall be considered due at the annual meeting and the name of any member two years in arrears for annual assessments shall be erased from the list of members of the society; and no such persons shall be restored to membership unless his arrearages shall have been paid or he shall have been reelected.

Article III

Officers

Sec. 1. The officers of the society shall be a president, a vice-president, a secretary-treasurer, and the members at large of the executive committee.

Sec. 2. The executive committee shall consist of the president, the vice-president, the secretary-treasurer and five members elected from the society at large. Of these five members, one shall be elected each year to serve five years. If any member at large shall be elected to any other office, a member at large shall be elected at once to serve out the remainder of his term.

Sec. 3. These officers shall be elected by ballot at the annual meeting of the society, and their official terms shall commence with the close of the annual meeting, except that the secretary-treasurer shall be elected triennially and shall serve for three years.

Sec. 4. The officers named in section 1 shall discharge the duties usually assigned to their respective officers.

Sec. 5. Vacancies in the board of officers, occurring from any cause, may be filled by election by ballot at any meeting of the society. A vacancy in the secretary-treasurership occurring in the interval of the meetings of the society may be filled by appointment until the next annual meeting by the executive committee.

Sec. 6. At the annual meeting the president shall name a nominating committee of three members. This committee shall make its nominations to the secretary not less than one month before the next annual meeting. It shall be the duty of the secretary to mail the list of nominations to all members of the society at least two weeks before the annual meeting. Additional nominations for any office may be made in writing to the secretary by any five members at any time previous to balloting.

Article IV

Meetings of the Society

Sec. 1. Unless previously determined by the society the time and place of the annual meeting of the society shall be determined by its executive committee. Special meetings may be called and arranged for by the executive committee. Notices of such meetings shall be mailed to all members of the society at least two weeks before the date set for the meeting.

Sec. 2. Sections of the society may be organized in any locality by not less than ten members, for the purpose of holding meetings for the presentation of scientific papers. Such sections shall have the right to elect their own officers and also associate members; provided, however, that associate membership in any section shall not confer membership in the society.

Article V

Quorum

Twenty five members shall constitute a quorum of the society, and four a quorum of its executive committee.

Article VI

Changes in the Constitution

Amendments to this constitution may be adopted at any meeting of the society by a two thirds vote of the members present, upon the following conditions:

(*a*) The proposed amendment must be in writing and signed by at least five members of the society.

(*b*) This signed proposal must be in the hands of the secretary at least one month before the meeting of the society at which it is to be considered.

(*c*) The secretary shall mail copies of the proposed amendment to the members of the society at least two weeks before the meeting.

By-laws

A set of by-laws, for the guidance of officers of the society in the performance of their duties, was also adopted in substance, but the work of embodying the same in appropriate and clear phraseology was delegated to the executive committee.

Officers of the society for the year 1914, as provided by the new constitution, were elected as follows:

President—C. E. McClung, University of Pennsylvania.

Vice-president—M. F. Guyer, University of Wisconsin.

Secretary-treasurer—Caswell Grave, Johns Hopkins University.

Additional Members, Executive Committee—To serve *one* year, H. E. Jordan, University of Virginia; to serve *two* years, H. F. Nachtrieb, University of Minnesota; to serve *three* years, H. V. Wilson, University of North Carolina; to serve *four* years, George Lefevre, University of Missouri; to serve *five* years, A. F. Shull, University of Michigan.

The treasurers of the Central and Eastern branches made financial statements, which were examined and found correct by an auditing committee consisting of Harold S. Colton and Wm. A. Kepner. These reports showed a total balance in current funds, December 30, 1913, of $597.22.

The custodian of the permanent fund, J. H. Gerould, reported the receipt of a 15 per cent. dividend on the claim of the society against the Industrial Savings and Loan Company of New York.

A finance committee consisting of Frank R. Lillie, chairman, Caswell Grave and E. G. Conklin, was created to have charge of the investment of the permanent fund and the executive committee was instructed to add to the permanent fund from current funds of the society whenever such action is deemed expedient.

A committee consisting of Henry B. Ward, chairman, G. H. Parker and C. E. McClung was appointed to confer with a committee of three from the American Society of Anatomists on the subject of premedical education.

The "Mathews Plan for the Organization of an American Biological Society" was referred to the executive committee for consideration and report to a future meeting.

The committee of delegates, on which the American Society of Zoologists was represented by G. H. Parker, recommended that the secretaries of the American Society of Zoologists and other affiliated societies consult with the secretary of the American Society of Naturalists as to the place of future meetings. This recommendation was approved by unanimous vote.

The recommendation of the executive committee that a list of members, and the new constitution and by-laws of the society be published this year by the secretary was also approved.

At meetings held on December 29, 30 and January 1, the following papers were read either in full or by title:

COMPARATIVE ANATOMY

The Intestinal Epithelium of Trematodes: HENRY S. PRATT.

A Contribution to the Evolution of the Cestode, Rostellum: FRANKLIN D. BARKER. (Illustrated with lantern slides.)

Barker and Adson have recently described a new genus and species of Cestode, *Protcorostellum sphærulum* from the intestine of softshell turtles.

This form differs from the other known genera of the *Proteocephalidæ* in having a well-defined apical organ on the head or scolex. Other morphological and histological differences also distinguish this form.

In order to arrive at the correct interpretation of this organ a careful comparative study of the various apical structures found in cestodes was made.

The comparative study shows that the apical organ of this new cestode from the turtle is neither end-organ, terminal sucker nor muscle-cone. The rostella of different cestodes vary greatly in their structural complexity so that several distinct grades may be recognized. Comparisons with these rostella clearly shows that the apical organ of the turtle cestode is a rostellum of a very simple type.

It seems then that we have in this rostellum the simplest and most primitive type of cestode rostellum yet described and one which possibly represents the prototype from which the more complex types have evolved. A well-defined series of rostella, developing in complexity, can be established, beginning with this very simple type found in the turtle cestode.

On the basis of this series of cestode rostella we would define the cestode rostellum as an organ varying in size, shape and complexity; having a definite individual musculature, intrinsic, extrinsic or both; more or less retractile; armed or unarmed; situated on the apex and equidistant from the acetabula of the cestode scolex. A more detailed discussion of this question will appear in a paper soon to be published from this laboratory by Geo. M. Covey on "The Microscopic Anatomy of *Protcorostellum sphærulum* Barker and Adson."

Further Notes on the Embryonic Skull of Eumeces: EDWARD L. RICE.

A. Secondary Tympanic Membrane.—Gaupp emphasizes the contrast in position of the secondary tympanic membrane of the mammals and the physiologically similar membrane stretched between the rim of the fenestra cochleæ and the lateral margin of the basal plate in *Lacerta*. Observations on *Eumeces* largely bridge this gap and indicate a real homology not recognized by Gaupp. Early stages agree with *Lacerta;* in later embryos the membrane is clearly a part of the wall of the otic capsule.

B. Exit of Glossopharyngeal Nerve.—The above interpretation helps to harmonize the seemingly contradictory data concerning the course of the ninth nerve in the reptiles, described as "Extra-capsular" in *Lacerta*, *Hatteria* and the *Crocodilia*, and as "intra-capsular" in *Chelone*, *Emys* and *Tropidonotus*. The cause in both cases may be interpreted as intra-capsular, the penetration of cartilage or connective tissue depending on the relative extent of these tissues in this part of the otic capsule, *i. e.*, upon the size of the fenestra cochleæ. Observations on *Eumeces* confirm this view. Some specimens agree fully with *Lacerta;* in others the nerve clearly penetrates the cartilage of the median walls of the capsule, although no lateral penetration of the cartilage has been observed. These variations are not correlated with age.

Observations on Sympathetic Ganglion Cells: F. W. CARPENTER.

The Vascular System of the Florida Alligator: A. M. REESE.

The Morphology of the Pectoral Spine and Gland in Certain Catfishes: H. D. Reed. (With demonstration.)

The Innervation of the Integument of Chiroptera: J. E. Ackert. (With lantern slides.) (Introduced by Robert K. Nabours.)

The integument of *Myotis lucifugus* (LeConte) and *M. sublatus* (Say), stained *intra vitam* with methylene blue, reveals a number of nervous structures. Among them are free nerve terminations which can be seen most readily in the flying and interfemoral membranes, and which, so far as the writer has been able to ascertain, have not been reported heretofore in these organs.

Nerves end on pelage hairs at three levels and in three different sheaths of the follicles. These endings are: (1) a superficial nerve ring situated ectad of the orifices of the sebaceous glands, and giving off nerve threads in the connective tissue sheath; (2) fine, varicose or flattened nerve fibrils lying immediately entad of the openings of the sebaceous glands, and terminating on the hyaline membrane parallel to the long axis of the hair; (3) nerve fibrils at the level of the lower third of the follicle, usually taking a horizontal position in the outer root sheath. Apparently, nerve endings similar to the last type have not been described previously in the hair of the bat.

The skin contains two kinds of special sensory end-organs: (1) a small, elongate *end-bulb* into which a single medullated nerve fiber enters, extends approximately to the opposite end, and terminates in a slight enlargement; (2) a large, round, cellular *terminal corpuscle* innervated by a single fiber which disappears among the cells of the organ. Terminal varicosities are abundant in the region of the hairs outside of the follicles.

In the skin of the face, especially, there are well-developed striated muscles which bear motor end-plates. While some of these plates appear to be beneath the sarcolemma in the integument, they are unquestionably so placed in the muscles of the tongue.

Of interest are the large, modified sweat glands, some of which have numerous fibrils running about them. In the absence of definite observations on the innervation of sudoriparous glands, it seems possible that these fibrils, which resemble sympathetic post-ganglionic neurites, may form plexuses about the glands similar to intracapsular plexuses around cell bodies of sympathetic neurones.

Blinded bats when on the wing probably perceive obstacles through the sense of touch by the effect of condensations of the atmosphere (produced on approaching the object) upon the free nerve terminations in the epidermis and the superficial nerve rings of the hair follicles.

EMBRYOLOGY

On the Parallelism Between Increase in Permeability and Abnormal Development of Fish Eggs: J. F. McClendon.

The morphology of abnormal *Fundulus* embryos has been studied by Dr. Stockard. My work has been merely an attempt to find the cause of the abnormalities.

I found that distilled or sea-water solutions of nicotine and the salts of Na, Li, K, Ca and Mg all produced the same abnormalities in the embryos. In other words, any one of the above substances produced all of the types of abnormalities when applied to eggs in early cleavage stages.

If the eggs are placed in distilled water or "balanced" salt solutions no salts diffuse out of them. Only the kations have to be balanced; for example, if eggs are placed in a solution containing nitrates of Na, K, Ca and Mg, no chlorides diffuse out of them.

But if the eggs are placed in distilled-water solutions of any one of these substances, the salts contained in the eggs diffuse out into the solutions and may be detected by ordinary chemical analysis. It is thus shown that solutions which cause abnormalities also increase the permeability of the eggs to salts (and perhaps to other substances).

Solutions that were too weak or had acted for too short a time to produce abnormalities, had increased the permeability of the eggs to a slight degree. Therefore, the increase in permeability seems to be the cause and not an effect of the abnormal development.

The Effect of X-rays on the Rate of Cell Division in the Early Cleavage of Planorbis: A. Richards.

An Experimental Study of Concrescence in the Embryo of Cryptobranchus alleghenienis: Bertram G. Smith. (Illustrated with lantern slides.)

By the method of vital staining the following facts concerning the formation of the embryo of *Cryptobranchus* were established: (1) A band of cells occupying the lateral and ventral parts of the equatorial region of the late blastula, during gastrulation comes to occupy the corresponding parts of the margin of the yolk plug, and converges on

the site of the closing blastopore. (2) During gastrulation there is a confluence of material lying in the region of the dorsal lip of the blastopore; in connection with the process of overgrowth and in turning of the dorsal lip of the blastopore this material shifts from either side toward the median line. (3) The movement of the neural folds is a movement of translation, not a wave movement. The neural folds include material originally situated at least 90 degrees apart, which is thus brought into apposition in the median line.

The bearing of these facts on the theory of concrescence will be discussed when the paper is published in full.

The Behavior of the Skeletons in Experimentally Fused Larvæ: A. J. GOLDFARB.

On the Behavior of Sea-urchin Embryos When Incorporated in Sea-urchin Lymph Plasmodia: H. V. WILSON.

Segmenting eggs included in lymph plasmodia, eventually in wound membranes, continued to develop for a time. Many reached through radial elongation of the blastula cells and subsequent delamination a solid (sterroblastula) stage, after which the cells became dissociated, lying scattered or in amorphous masses in the midst of the general plasmodium. A large amount of the embryonic tissue underwent degeneration. On the other hand, groups of small dissociated blastomere cells established connection with one another and the general lymph plasmodium through the development of protoplasmic processes. They thus went so far as to become a part of the syncytium which constitutes the regenerative tissue. Their further fate could not be traced, and the evidence as to their permanency is thus negative.

In some of the experiments a considerable number of segmenting eggs remained adherent to the surface of the plasmodium. The development of these was near the normal. About the time when the cells acquire cilia, instances of fusion between the blastulæ were common. While the further development of these giant blastulæ was not followed, it would seem that the combination of lymph plasmodium and giant embryos is something essentially like the "syrphoplasmic" masses described by Janssens (1904).

A Pair of Tracheal Invaginations on the Second Maxillary Segment of the Embryo of the Honey Bee: J. A. NELSON.

At a period shortly after the completion of the germ layers, and contemporaneous with the appearance of the rudiments of the appendages and of the stomodæum, a pair of tracheal invaginations appears on each of the ten segments caudad of (but not including) the prothoracic segment. These invaginations by branching give rise to the tracheal system. At the same time a pair of invaginations appears on each side of the second maxillary segment. These occupy a position on this segment similar to those of the tracheal invaginations of the trunk segments, and are also similar to them in size and general appearance. Each of the tracheal invaginatious of the second maxillary segment is directed somewhat caudad, and develops with great rapidity into a sac with four diverticula and a constricted external opening. One of the diverticula is directed caudad, one dorsal and the other two cephalad.

The external opening of the tracheal invagination now closes completely, the branched sac thus formed being cut off completely from the hypodermis. The caudad diverticulum of the sac now extends further caudad to meet and unite with the cephalad diverticulum from the tracheal invagination of the second thoracic segment. The dorsal diverticulum extends toward the dorsal mid line, where it meets and fuses with the corresponding diverticulum of the opposite side, forming the anterior tracheal loop or commissure of the main tracheal trunks. The two cephalad diverticnla form tracheal branches supplying the brain and the muscles of the cephalic appendages. The tracheal invaginations on the second maxillary segment, therefore, produce a portion of the anterior end of each of the main tracheal trunks, in addition to the tracheæ found in the head.

Tracheal invaginations were described by Hatschek in 1877 in the gnathal segments of a lepidopterous larva. Examination of Hatschek's figures show that these invaginations were those forming the tentorium and mandibular apodemes, and they have generally been so regarded. Tracheal invaginations have not since been described in the head of any insect embryo.

Further Studies on the Development of the Cranial Sympathetic Ganglia in Vertebrates: ALBERT KUNTZ.

The Early Cleavage of Cirratulus Grandis, Verrill: JOHN W. SCOTT. (Illustrated with lantern slides.)

In common with most annelids the cleavage is unequal. It differs from other marine annelids in that cleavage becomes very irregular after the 8-celled stage. The egg is further characterized by the peculiar and important behavior of the yolk

lobe. The egg shows a high degree of organization at an early stage. Whatever may be the significance of the yolk lobe, it is an adaptation associated with early cleavage, apparently correlated with the karyokinetic figure; it aids in producing unequal cleavage; it isolates cell materials, so that they are unaffected by early transformations of the nucleus; and, in *Cirratulus*, it appears to aid in the arrangement of the cell pattern. Conklin's theory ('12), that the yolk lobe is due to a weak spot in the protoplasmic pellicle, through which the lobe is forced out by "mitotic pressure," is inadequate. For this theory would not explain the non-appearance of the lobe in *Cirratulus* at the third cleavage, though it appears in both earlier and later stages.

A Solution of the Problem of Yolk Manipulation by Ophiura: Caswell Grave.

The egg of the brittle-star, *Ophiura brevispina*, contains a very large amount of yolk and in its cleavage and early development this yolk, in the form of minute spherules, is equally distributed to all of the cells.

In its yolk distribution it, therefore, does not differ from the eggs of other Echinoderms but does differ greatly from those eggs of Arthropods, Molluscs and Vertebrates which are rich in yolk. In the latter, the yolk is early segregated either into a few inert cells or into a portion of the egg from which the active cells withdraw during development.

In consequence of the large amount of yolk in the egg of *Ophiura* and of its equal distribution to every cell during segmentation and early development, a comparatively large amount of the energy of the egg is expended in the manipulation of its yolk content. For example: the resting cells of the blastula have the form of slender prisms, their length being to their breadth as nine is to one. During its mitosis, however, each cell becomes approximately spherical in shape. Connected with this enormous change in shape and position of a dividing cell, there takes place a very considerable readjustment of adjacent cells and their contents and especially an entirely new arrangement of the yolk spherules of the dividing cell.

The interesting observation herein reported is that this expenditure of energy in juggling with yolk spherules ceases when a stage in larval development is reached in which the gut and cœlom are differentiated. At this stage the cells extrude practically all of their supply of yolk into the blastocœle cavity. The redistribution of this mass of yolk to the tissues of the organism is a function of amœboid mesenchyme cells.

CYTOLOGY

The Nerve Centers of the Electric Organ in Raja Punctata: Ulrich Dahlgren. (Illustrated with lantern slides.)

The X-element of Plymouth Rock Fowls: M. F. Guyer. (With demonstrations.)

Chromosomal Variations in the European Earwig, Forficula Auricularia: F. Payne.

Spermatogensis in Chrysemys marginata and Cistudo carolina: H. E. Jordan.

Chromidia appear to originate in the spermatogonia by a process of extrusion of chromatic particles from the nuclear recticulum. In *Chrysemys* the chromosomes during early growth stages are aggregated in or upon the nucleus; from here they disperse as small paired granules or rods; subsequently the chromosomes enlarge; the typical synapsis figure is absent. The nucleolar residue persists in part as a compact oval or paired-rod element, suggesting an accessory chromosome. The haploid number of chromosomes is 17, including one larger U-shaped element which passes apparently undivided (frequently as a pair of rods) and in advance of the other chromosomes to one pole of the first maturation spindle. In *Cistudo* a typical synapsis figure appears; the haploid number of chromosomes is 16; and there is no evidence similar to that in *Chrysemys* suggesting an X-element. Numbers of the secondary spermatocytes apparently divide amitotically, perhaps an abnormal condition.

A Microscopical Investigation of Tissues From Dogs Which Fasted Extremely Long Periods of Time: S. Morgulis, P. E. Howe and P. B. Hawk.

The Germ-cell Cycle in Animals: R. W. Hegner.

Of the nine periods into which the germ cell cycle in animals may be divided, two were discussed: (1) Cyst-formation in the testis of the potato beetle, *Leptinotarsa decemlineata*, and (2) the localization of the germ-cell substance in the unsegmented egg. At a certain stage in the multiplication period the spermatogonia of the potato beetle become each surrounded by epithelial cells. Each spermatogonium divides by mitosis and the daughter cells can be identified because of connecting strands—the remains of the spindle. These spindle-remains enable one to prove conclusively

that all of the spermatozoa in a single cyst arise from a single spermatogonium. These divisions constitute a period which parallels that in *Dytiscus* during which one oogonium produces fifteen nurse cells and one oocyte. The germ cell substance in many animals is localized in the unsegmented egg and can be distinguished by the presence of stainable inclusions which may be named keimbahn-determinants.

The Orientation of the Nuclear Organs in the Electric Motor Cells of Tetronaree and Other Torpedoes: ULRICH DAHLGREN. (Illustrated with lantern slides.)

Chromosomes in Opalina: M. M. METCALF.

The Physical Changes in Marine Eggs in Fertilization: G. L. KITE. (Illustrated with lantern slides.) (Introduced by C. E. McClung.)

The Molar Structure of Protoplasm: G. L. KITE. (Introduced by C. E. McClung.)

The conclusions presented in this paper are founded on the dissection of representative cells of widely different types of animals and plants. A detailed investigation of the principal kinds of cells of the frog and rabbit has been made.

Protoplasm has been found to be composed of gels and sols. With few exceptions resting nuclei are rather rigid gels which contain denser areas. Such areas are frequently arranged in the form of imperfect networks. The cytoplasm is usually in the gel state and may contain globules, granules and fibrils. The globules are completely separated from the imbedding gel, while granules and fibrils grade into the contiguous substance.

Dividing cells have proved to be of special interest. Chromosomes and spindle fibers seem to be incomplete separation products. The changes which result in the separations are at least partially reversible. Experiments on different kinds of dividing cells point unmistakably to the fact that the chromosomes and spindle fibers play a secondary rôle in indirect cell-division. The optically undifferentiated protoplasm, lying around and between the chromosomes and spindle fibers and in the plane of cleavage, is the portion that is the seat of the active changes that result in cell-division.

The chief general conclusion from this study is that protoplasm is a one-phased system in molar structure. Dissections of cells under quite satisfactory optical conditions have failed to reveal the contiguous solid and liquid phases that are generally held to be the essential elements of protoplasm.

GENETICS

A Male Gynandromorph of Colias (Eurymus) Eurytheme Showing Dimorphism in the Female Color Pattern: JOHN H. GEROULD. (Illustrated with lantern slides.)

Inheritance in Orthoptera: ROBERT K. NABOURS.

During five years many types with complex color patterns of *Paratettix* Bolivar, of the Orthopteran subfamily Tetriginæ, have been captured and bred in the greenhouse, for two years at the University of Chicago and three years at the Kansas Agricultural College, Manhattan. From these have been segregated through Mendelian analyses about fifteen true breeding types. These true breeding forms have been recombined to make all the original hybrid types and many others which have not as yet been found in nature. Ten true breeding types have been tried, and, with one exception, each has been found to pair with each of the others, making as many allelomorphic pairs as there are possible combinations. Some of the cultures have been carried to the F_4 generation, and some of the forms have been bred, in one combination or another, for sixteen generations. The results throughout have been typically Mendelian, except that one form, *P. melanothorax* (*G*), when crossed with any other form, produces F_1 progeny that do not always give gametes alternatively, but seem to give some gametes that represent both parents. For instance a *melanothorax* (*G*)—*leuconotus* (*B*) hybrid mated with a *leucothorax* (*C*) homozygous form gives *CG*, *BC* and *BCG* progeny. Reciprocal crosses have invariably given identical results.

The Effect of Selection Upon Egg Characters in Parthenogenetic Lines of Hydatina: A. FRANKLIN SHULL.

Fifty Generations of Selection in Parthenogenetic Pure Lines of Daphnids: A. M. BANTA.

Selection experiments in pure parthenogenetic lines of daphnids were reported on. In all eighteen lines were continued under selection for eight generations or longer and eleven for from thirty to fifty generations. The daphnids belong to three species and were originally taken from several different ponds near Cold Spring Harbor. Fourteen of these lines are *Daphnia pulex*, two belong to another species of *Daphnia* and two are *Simocephalus*.

The character used as the basis for selection was purely a physiological one, the daphnids' reaction to light. In the beginning of the experiment the

first brood from a young mother was placed in the experimental tank under carefully controlled conditions and while still only a few hours old. The first one of these young to reach the positive end of the tank was selected for the beginning of the + stain and the one last reaching the positive end, or failing to reach it within a given time, for the beginning of the — strain. In a similar manner the selections were made in later generations. To August first for the whole period during which selection had been continued the mean reaction time of the + strains of four of the lines was greater than the mean reaction time of the corresponding — strains, this indicating presumably a greater responsiveness to light on the part of the + strains in spite of the selection for the reverse effect. Two of these differences are statistically significant, as they are more than two and one half times the probable error. In fourteen of the eighteen lines the — strains have a higher reaction time than the corresponding + strains and in eight of these the differences are statistically significant. Of the lines selected for from thirty to fifty generations two have a higher mean reaction time in the + strain and nine in the — strain. The two former and six of the latter differences are statistically significant.

Size Differences in the Spermatozoa from Single Testes: CHARLES ZELENYA AND E. C. FAUST.

Measurements were made of the length of the head in five hundred or more spermatozoa of each of twelve species of animals. The variation curves plotted from these measurements were used in determining the probable presence or absence of size dimorphism.

In *Anasa, Lygæus, Alydus, Musca, Melanoplus femur-rubrum, Melanoplus differentialis* and *Phytonomus* among insects and *Pseudomys* and *Bos* among vertebrates the curves are distinctly bimodal and indicate the presence of two size groups. The inference is made that the group of larger spermatozoa is the one with an X chromosome and the group of smaller spermatozoa the one without an X chromosome.

Segregation of Traits in a Pennsylvania Family: WILHEMINE E. KEY.

Some Reactions of the Shell of the Pond Snail, Lymnæa, to External Conditions: HAROLD S. COLTON.

A Quantitative Basis of Sex as Indicated by the Sex Behavior of Doves From a Sex Controlled Series: OSCAR RIDDLE.

By his method of controlling sex in pigeons Whitman showed (1) that the first young of the season (spring and early summer) were nearly all males, and young hatched from the later eggs of the season were nearly all females; (2) that if the two sexes arise from the two eggs of any one clutch, that it is in nearly all cases the first egg which produces the male, and the second egg of the clutch that produces a female; (3) that birds kept thus mated and overworked at egg-production tend to produce in succeeding years fewer and fewer males before the appearance of females.

A study of the sex behavior of the females of one such series (reciprocal cross of *T. orientalis* × *S. Alba*) has shown (1) that the females (dark in color) of the *alba* × *orientalis* cross are more masculine in their sex behavior (*i. e.*, function more times as males in copulation) than the females (white in color) of the reciprocal cross; (2) *that females of either cross hatched early in the season, i. e., closest to male-producing conditions, are more masculine in their sex behavior than their own sisters hatched late in the season from eggs produced under strongest female-producing conditions;* (3) that two full sisters hatched from the two eggs of a single clutch most strongly contrast with each other. *The bird from the first or male-producing egg of the clutch usually taking the part of the male to a full 100 per cent.*

The injection (over a period of one month) of extracts and suspensions of ovarian tissue into the more masculine of these females, with simultaneous injections of testicular extract and suspension into the more feminine of the pair, *has succeeded in some cases in very strongly reversing the sex behavior of the pair.* The effect persists more than 25 days after the last injection.

The behavior itself, and the effects of the extracts, have been recorded on moving picture films.

These two results together with our very abundant data on the storage metabolism of the ova of these forms, and the initial fact of sex control itself, strongly indicate that the basis of sex is a fluid, reversible process; that the basis of adult sexual difference is a *quantitative* rather than a *qualitative* thing.

Size Inheritance in Rabbits: E. C. MACDOWELL. (Introduced by W. E. Castle.)

To test the hypothesis that the apparent blending inheritance shown by Castle's work on the ear length of rabbits may be interpreted by the multiple factor hypothesis established by Nillson-Elbe,

these experiments were planned and started by Professor Castle. They were handed over to the writer in the fall of 1909. Crosses were made between rabbits of large and small body size; the offspring were crossed back to the parents to produce a back-cross generation. Based upon the statistical study of bone measurements and body weight as estimated from growth curves, it was found that the back-cross was more variable in size than the first generation. This was shown by standard deviations as well as by classifications of the actual measurements in relation to the parents. Certain measurements from the back-cross rabbits reached and exceeded the parental extremes. The means of both generations were very close to the mid-parentals in both generations. All these facts would be expected if the multiple-factor hypothesis be used to construct a mechanism to account for size inheritance. The increased variability would be due to a segregation of size factors.

CASWELL GRAVE,
Secretary

(*To be continued*)

THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE eighth annual meeting of the Entomological Society of America was held at the Atlanta Medical College, Atlanta, Ga., December 30 and 31, in affiliation with the American Association for the Advancement of Science. In the absence of President Bethune, the meetings were presided over by Dr. Philip P. Calvert. The meetings were all well attended, there were about fifty members and fellows in attendance.

The following papers were presented:

"The Structure of the Hind Intestine of *Corydalis*," by J. T. Lloyd.

"Observations on the Habits and Life-history of *Hydromysa confluens* Loew.," by Paul S. Welch. (Read by title.)

"New Characters in the Classification of Microlepidopterous Larvæ," by Stanley B. Fracker.

"The Poison Glands of *Euproctis chrysorrhœa* Linn.," by Cornelia F. Kephart. (Presented by W. A. Riley.)

"The Tracheation of the Anal Area of the Wings of the Lepidoptera and the Homology of the Veins," by N. L. Partridge. (Read by title.)

"The Box-elder Bug in Ohio," by Herbert Osborn.

"The Elytral Tracheation of the Subfamilies and Genera of Cicindelidæ," by V. E. Shelford.

"Some Interesting Structures in the Pupæ of Lepidoptera," by Edna Mosher.

"Some Sources of Error in the Interpretation of Insect Tissue," by W. A. Riley.

"*Conventzia hageni* Banks, Life-history Notes and Variations in Wing Venation," by J. S. Houser.

"Notes on the Head Structures of Thysanoptera," by Alvah Peterson. (Read by title.)

"The Desirability of a Biographical Dictionary of Entomologists," by Philip P. Calvert.

The afternoon of the thirtieth was devoted to a joint session of Section F of the American Association for the Advancement of Science and the Entomological Society of America, at which the following papers were presented:

"Note on the Present Status of the Gipsy Moth Parasites in New England," by L. O. Howard.

"Some Notes Regarding the Natural History of the Mole Cricket," by E. L. Worsham.

"Notes on Some Old European Collections," by H. T. Fernald.

"Studies on the Snowy Tree-cricket, *Œcanthus niveus*, with References to Apple Bark Diseases," by P. J. Parrott, W. O. Gloyer and B. B. Fulton. (Presented by P. J. Parrott.)

"Collecting Insects in the Okefenoke Swamp," by J. Chester Bradley. (Presented by J. G. Needham.)

"Studies on the Geographical Distribution of Leaf-hoppers, Especially of Maine," by Herbert Osborn.

"The Fauna of Epiphytic Bromeliads in Costa Rica," by Philip P. Calvert.

The morning of the thirty-first was devoted to the presentation of the report of the executive committee, at which was reported the election of fifty-four new members and the election of Dr. C. Gordon Hewitt and Dr. William Barnes as fellows; the presentation of the reports of standing committees; the election of officers; the adoption of the report of the committee to hold a summer meeting in 1915 on the Pacific coast; the appointment of a committee to consider the desirability of starting the publication of a series of special works on entomology like that of the Ray Society, and the reading of the following papers:

"The Dispersal of *Musca domestica*," by James Zetek. (Presented by S. B. Fracker.)

"A Comparison of the Enemies of *Toxoptera graminum* in South Africa and the United States," by William Moore. (Presented by F. L. Washburn.)

"Life-history Notes on *Psephenus lecontei* and *Hydroporus septentrionalis*," by Robert Matheson. (Read by title.)

"The Sequence of Color Changes During Ontogeny in *Cicindela*," by V. E. Shelford.

"Notes on the External Anatomy of Some Pentatomidæ," by R. W. Leiby.

"The Biology of *Gelechia gallæsolidaginis* with Some Reference to Some of Its Parasites," by L. S. Barber.

"A Little Known Wire-worm, *Horistonotus uhleri*," by A. F. Conradi.

"The Life-history of a Species of Psychodidæ," by Leonard Hazeman. (Read by title.)

"The Structure of the Thorax in Generalized Insects," by A. D. MacGillivray.

"Behavior of *Anopheles tarsimaculata* Goldi," by James Zetek. (Read by title.)

"Life-history of *Elophila magnificalis*, an Aquatic Lepidopteron," by J. T. Lloyd. (Read by title.)

The following officers were elected for 1914:

President—Dr. Philip P. Calvert, University of Pennsylvania.

First Vice-president—Dr. James G. Needham, Cornell University.

Second Vice-president—Dr. C. Gordon Hewitt, Dominion Entomologist.

Secretary-treasurer—Dr. Alex. D. MacGillivray, University of Illinois.

Additional Members of the Executive Committee—Professor Herbert Osborn, Ohio State University; Dr. W. M. Wheeler, Harvard University; Professor Vernon L. Kellogg, Leland Stanford Junior University; Mr. Nathan Banks, United States National Museum; Dr. E. P. Felt, State Entomologist of New York, and Professor J. M. Aldrich, United States Bureau of Entomology.

Member of Committee on Nomenclature—Professor T. D. A. Cockerell, University of Colorado.

The next meeting will be held in Philadelphia, Pa., in affiliation with the American Association for the Advancement of Science.

Alex. D. MacGillivray,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixty-eighth regular meeting of the society was held at Columbia University on Saturday, February 28. The attendance at the two sessions included forty-two members. Vice-president L. P. Eisenhart occupied the chair. The following new members were elected: Mr. E. W. Castle, Princeton University; Professor P. J. Daniell, Rice Institute; Mr. L. R. Ford, Harvard University; Mr. C. M. Hill, State Normal School, Springfield, Mo.; Dr. R. A. Johnson, Adelbert College; Dr. L. M. Kells, Columbia University; Dr. W. W. Küstermann, Pennsylvania State College; Professor J. F. Reilly, State University of Iowa; Professor F. B. Williams, Clark University. Nine applications for membership were received.

An amendment of the constitution was adopted by which the secretary of the Chicago Section becomes *ex officio* a member of the council.

The following papers were read at this meeting:

H. S. Vandiver: "Note on Fermat's last theorem."

G. M. Green: "One-parameter families of space curves, and conjugate nets on a curved surface."

G. M. Conwell: "Brachistochrones under the action of gravity and friction."

R. D. Beetle: "A formula in the theory of surfaces."

C. A. Fischer: "The Legendre condition for a minimum of a double integral, with an isoperimetric condition."

A. R. Schweitzer: "A generalization of functional equations."

A. R. Schweitzer: "Some critical remarks on analytic realism."

E. V. Huntington: "A graphical solution of a problem in geology."

H. Galajikian: "A relation between a certain non-linear Fredholm equation and a linear equation of the first kind."

Dunham Jackson: "Note on rational functions of several complex variables."

E. B. Wilson: "Infinite regions in geometry."

H. Bateman: "The structure of the aether."

F. R. Sharpe and Virgil Snyder: "Birational transformations of certain quartic surfaces."

F. R. Sharpe and C. F. Craig: "An application of Severi's theory of a basis to the Kummer and Weddle surfaces."

B. E. Mitchell: "Complex conics and their real representation."

W. H. Roever: "Analytic derivation of formulas for the deviation of falling bodies."

The next meetings of the society will be held at Chicago, April 10–11, and at New York, April 25.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, MARCH 27, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

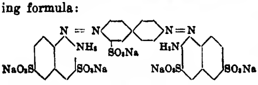
THE ACTION OF VITAL STAINS BELONGING TO THE BENZIDINE GROUP[1]

THE brilliant advances in our knowledge of the chemistry of aniline dyes, brought about naturally by the enormous commercial importance which the dyes possess, has been brought to bear, and will in the future be brought to bear, we believe, in the solution of some important problems in biology. The dyes possess peculiar advantages; especially is this true in the case of those of them which undergo little or no chemical transformation when injected into the living body. To this class of dyes, as we hope to show later, belong the benzidine or substantative dyes. It might be inquired immediately whether vastly more important results could not be secured from the study of dyes which, on the contrary, are known to suffer definite chemical changes within the body, for it might be supposed, for instance, that valuable light could be thrown on oxidative or reductive processes peculiar to certain cells or tissues. It was, of course, with motives not far removed from these, that Ehrlich first seriously attempted the use of dyes to solve the problem of the relation between pharmacological action and chemical constitution in his classical essay on this thesis in 1902. When we insist, however,

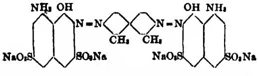
[1] Read at the session of the National Academy of Sciences, Baltimore, November 18, 1913. From the Anatomical Laboratory, Johns Hopkins University and the Kgl. chirurgisches Institut, Breslau. The study is a preliminary report of observations which will be presented in full in the Memoirs of the Rockefeller Institute for Medical Research and which were rendered possible by grants from the Rockefeller Institute and the Robert Koch Stiftung, Berlin.

that the study of dyes which suffer no chemical change within the body is of the highest value and indeed calculated to lead us to results which can be secured in no other way, we do so mainly because the class of dyes to which we refer can be injected in relatively large quantities into the blood stream of living animals without perceptible toxic effect; and the dye, taken care of as it were by definite cells which store it unchanged within their cytoplasm, can be detected without difficulty, wherever it may be, on account of its color.

In 1905, Ehrlich and Shiga, then attempting the cure of trypanosome infections in laboratory animals, happened to find that the azo dye, which they named trypan red and which possesses the following formula:



could be injected in sufficient quantity into the living animal to kill the organisms of the disease without perceptible toxic effect to the cells or tissues of the host, themselves deeply stained. A year later, driven thither in the same quest, Nicolle and Mesnil, of Paris, discovered a similar effective compound or "good color" as they called it in trypan blue, a dye formed by the combination of two molecules of 1.8 amidonaphtol 3.6 disulphonic acid with one molecule of diazotized ortho-tolidine in alkaline solution.



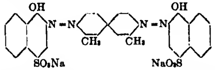
The profound color of the healthy animals which received this dye could not fail to attract the attention of Nicolle and Mesnil, who set Boufard the fascinating problem of determining in what form the dye persisted in the body. His report, which was all too short, nevertheless acquainted us with the main fact that the dye had not merely remained in the fluids of the body or had pervaded the organs and tissues in a profuse way, but was engulfed in the bodies of certain definite cells primarily of one type which we shall have occasion to describe carefully shortly. Coincidently Goldman at Ehrlich's suggestion took up the same theme, and his enthusiastic studies have in spite of occasional inaccuracy attracted general interest to the subject.

Nowhere however in the rapid literature which has begun to accumulate on this subject can one find an attempted answer to the fundamental question of how the dye really acts on the cells of the body, *i. e.*, what property it is by virtue of which one of the members of this class of dyes is enabled to be a brilliant vital stain; whereas a closely related dye is a complete failure. Nor, secondly, does it seem to me that full advantage has been taken of the great opportunity bestowed by these dyes in enabling us to detect a hitherto unknown or unrecognized function of a great mass of cells all over the body which can now be grouped together under a common designation as a great system or tissue.

If we inject into the peritoneal cavity of a mouse 1 c.c. of a one half per cent. solution of trypan blue, we can observe within a few minutes that the ears, the tip of the nose, the tail, the mucous membranes and soon the skin of the entire body have begun to blue, and that this deepens rapidly in intensity, so that within a few hours a maximal deep blue color is possessed by the animal, a color which, in spite of this single dose, is not lost for many weeks. The animal thus stained plays, eats, breeds, and in all ways manifests its normal activity, and

there is no evidence of the ill effect of the dye.

If now instead of trypan blue we employ the brilliant blue dye azo-blue whose constitution is



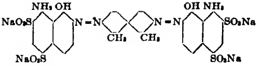
we are met by a striking difference. Neither within minutes or hours after the intraperitoneal injection of such a dye is any trace of color to be seen from the dye, and the repeated injection of the dye over a long period of time does not in any way change this negative result. The autopsy of such an animal shows indeed that we have heaped upon it a large quantity of a colored foreign body, for the dye has remained on the whole where it was injected; that is, in the peritoneum and the structures connected with it. Why this difference?

Several notions have been advanced in explanation of the action of vital stains. Primarily we have to do with the ideas, first, that a chemical union exists between the dye molecules and some portion of the cell protoplasm, and, second, the theory that dyes owe their ability to stain vitally to some physical property by virtue of which they can penetrate the cell. The name of Ehrlich is connected with the first of these two views, while that of Overton is identified with the second, and we may mention here that the commonest physical rather than chemical explanation of vital staining has been that the dyes in question are soluble in fat or fat-like bodies, a layer of which was assumed to envelop the cell. While this explanation may have been convincing in the explanation of vital staining obtained by the earliest known vital stains (methylene blue and neutral red) we are aware now that both of the assumptions involved in it were gratuitous, for neither are the benzidine dyes soluble in fats or lipoids nor are the majority of the cells of the body surrounded by a layer of these substances. If, then, in spite of the above, we must maintain that after all physical factors play a predominant rôle in the vital staining produced by the azo or benzidine dyes, it is for reasons quite apart from those involved in Overton's lipoid theory.

The chemical explanation of a vital stain presupposes that there exists between some element of the protoplasm of the cell, the chemo-receptor in the sense of Ehrlich, and some part of the dye molecule a combination, such as we are accustomed to see take place between two bodies in accordance with the laws of formal valence. It is only necessary to show how important such an explanation is in the mind of Ehrlich by mentioning the fact that he assigns the therapeutic effects of the drug salvarsan primarily to an affinity which he assumes to exist between the parasites of syphilis and a precise part of the salvarsan molecule; namely, the ortho-amido-phenol configuration. The application of this principle in an explanation of the vital stain produced by trypan blue must lead us to maintain that a similar configuration, *i. e.*, the peri-amido-naphtol configuration, is really responsible for the union between dye and cell which gives us the vital stain here. We can dispense with such reasoning shortly.

Evidence which would appear to concern the efficacy of a peri-amido-naphtol ceptor is furnished by the brilliant vital staining produced by the dyes Nos. 1824, 1835 and 1846, in all of which the hydroxyl and amido groups are in a peri position to one another, and the azo bond at position II.

No. 1824



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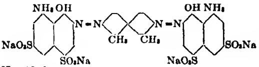

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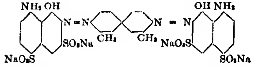
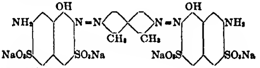


Furthermore, the production of exactly as brilliant a result by dyes in which merely the position of the OH group has remained constant, the NH_2 group either being absent or shifted in its position, might lead us to suppose that it is the alpha position of the hydroxyl radicle rather than the entire peri-amido complex which in all these cases has determined the vital stain. We mention of such dyes the vital stains 2836, 1836 dioxy, 1527, 136, 1368.

No. 2836



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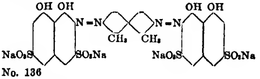

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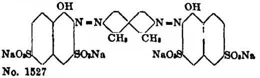

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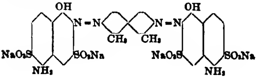

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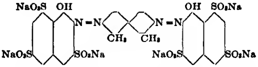
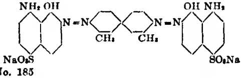


This conclusion, however, (*i. e.*, that an alpha-naphtol receptor has been responsible for the staining) must be rejected at once as soon as we examine the dyes 184, 185, 257, 258, 286, 184 dioxy 14 and 15 all of which can be injected into animals without producing a vital stain.

No. 184



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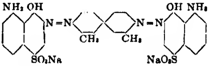

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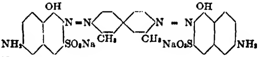

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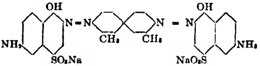

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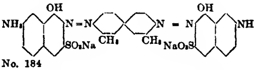
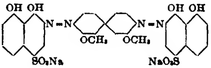
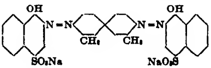


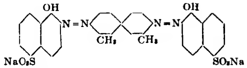
No. 184



No. 14

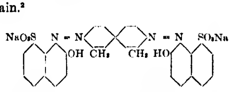


No. 15



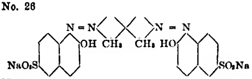
It is apparent then from the foregoing that if the alpha-naphtol receptor is to work, it can only do so in the presence of two sulfonic acid groups.

When, now, we examine the behavior of the beta-naphtol sulfonic acids in this respect, we find that, strangely enough, one of the monosulfonic acids (namely the 2.8 acid) produces a dye which acts as a vital stain.[3]

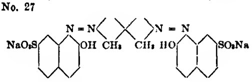


The other mono acids which we have examined (the 2.6 and 2.7 acids) produce entirely negative dyes.

No. 26

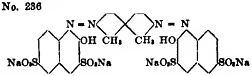


No. 27



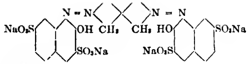
Whereas of the disulfonic acids, the 2.3.7 and 2.6.8 acids produce dyes which are nonstainers, the 2.3.6 acid combined with tolidine furnishes a dye which approaches a true vital stain.

No. 236

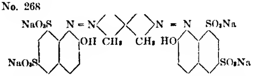


[3] The dye was made for us by Dr. Taggesel through the kindness of Schaellkopf, Hartford and Hanna, Buffalo.

No. 237



No. 268

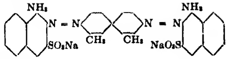


A comparison of the different effects secured by the two dyes 236 and 237 is interesting, for it is difficult to believe that the exact position which the sulfonic acid radicle assumes in the naphthaline ring is an adequate explanation of this. In all the dyes which we have examined, the number of sulfonic groups has been important, but not the position which they occupy. The precise point of insertion in the naphthaline ring was of little moment and we have to inquire in dyes 236 and 237 why the shifting of one SO_3Na group from 6 to 7 changes a positive into a negative dye. Now these two isomeric acids, apart from their close chemical relationship, have long been known to produce dyes which differ greatly in some of their non-chemical characteristics—characteristics which we believe determine whether a dye of the benzidine class shall be a vital stain or not.

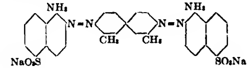
For the present, however, let us believe that there is a general alpha-naphtol-disulfonic ceptor, a particular beta-naphtol-disulfonic ceptor (viz., the 236 one) and a particular beta-naphtol-monosulfonic ceptor (the 28 one) whereas none of the other monosulfonic and none of the other beta disulfonic acids have chemoceptors corresponding to them in the cell.

When we consider the dyes made from the naphtylamines we must still further extend our list of hypothetical chemoceptors, for many of these dyes are brilliant vital stains, among them 13, 15, 16, 26, 27 and 28.

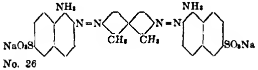
No. 13



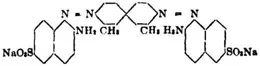
No. 15



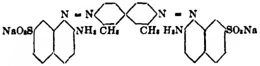
No. 16



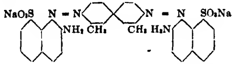
No. 26



No. 27

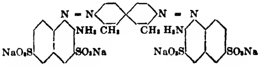


No. 28

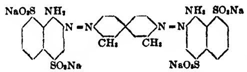


Both of the naphtylamine disulfonic acids with which we have worked have yielded equally brilliant results (the 2.3.6 and 1.4.8 ones).

No. 236

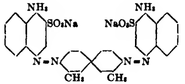


No. 148

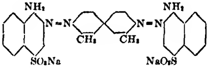


We meet, however, among the naphtylamines surprises which are just as remarkable as those which greeted us in the naphtol group, for the isomeric dyes which are listed below (12, 14, 17, 18 and 25) are all negative.

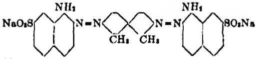
No. 12



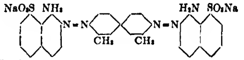
No. 14



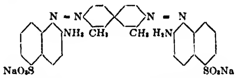
No. 17



No. 18

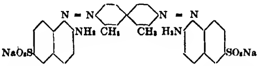


No. 25



We shall not have to insist that it is hardly likely that chemical reaction between these dyes and substances with which they could truly combine would hardly occur or fail to occur in this capricious way. Our results then are hardly capable of being formulated in terms of the chemoceptor theory, for there is no one chemical configuration which we are able to pick as a chemoceptor. Our search at this juncture for some common characteristic possessed by a positive in contrast to negative dye, a characteristic which when possessed always permitted the dye to be a vital stain and when absent led us to predict its failure, was rewarded with success. We were in short induced to look into the phys-

ical state of the dye solutions. Our attention was rather dramatically called to this phase by experiments with benzo-purpurine B:

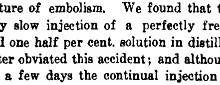


A fresh, cold one-per-cent. solution of this dye can be injected rapidly into the ear vein of the living rabbit and will produce within a few minutes a beautiful diffuse coloring of the whole animal, a coloring which though at first affecting merely the body fluid, can in a few hours be seen to have established itself in the form of granules in that distinct class of cells which are affected by dyes of this group. If, on the other hand, we inject a similar cold solution of this dye, but one which has been allowed to stand a few days before using, the animal invariably dies before our eyes with typical symptoms of cerebral embolism. If we boil the dye for a little while with Ringer's solution instead of with water, the effect is even more marked, for a single cubic centimeter of such a solution after it has been allowed to cool, kills the animal instantly on injection. Why are the dye solutions so different in their behavior? A few test-tube experiments sufficiently answered our question, for we were dealing with an electrolytic precipitation of a colloid, whose coagula were sufficient to plug the cerebral vessels. By testing in this way all of the dyes which we have reported as negative, we were able to show that no one of them failed to produce embolism on injection.

But while thus dangerous in the living blood stream there might still be thought to be no reason why these dyes should fail to act when placed under the skin or in the body cavity. In these situations, however, the dyes remain without invading much of the remainder of the body, and we were led to test the diffusion power of positive and negative dyes in a medium where it was slow enough to be measured, *i. e.*, in 2 per cent. gelatin, and without presenting here our tabular results we found no exception to the rule that positive dyes possessed a rapid diffusion rate, while negative dyes little if any diffusion at all.

These facts harmonize, of course, perfectly with our knowledge of the behavior of colloids, and make it certain that we are dealing with phenomena which depend on the size of the particles or aggregates in our solution. A negative dye could not reach many cells in the body, for its particles are all large and rapidly agglutinated in the body fluids, and such large particles have slight, if any, power of diffusion. Did, however, the cells in their neighborhood accept these negative dyes?

The investigation of the cells of the subcutaneous tissues at the injection site showed that even with the most negative dyes a vital staining in this limited zone had always taken place. Our failure to stain more cells then was due solely to our inability to reach them. We proved this contention, we believe, conclusively by selecting a dye D-14.

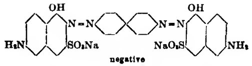


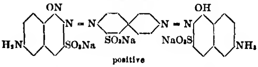
which when placed under the skin has practically no powers of diffusion and which when injected at a normal rate into the blood stream always kills with the typical picture of embolism. We found that the very slow injection of a perfectly fresh, cold one half per cent. solution in distilled water obviated this accident; and although for a few days the continual injection of

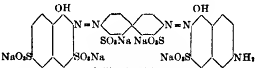
the dye did not color the skin or mucous membranes of the animal, this was eventually obtained. The study of an animal in the early stage of such a series of injections is most interesting. We have indicated that such a negative dye must consist chiefly of large particles, and since little color appears in the urine of these animals, and the animal is externally unstained, it is evident that the dye particles are engulfed by cells internally located. The autopsy of such an animal shows that not only the skin but most of its tissues are free from dye with four notable exceptions; namely the liver, the spleen, the lymph-glands, and the bone marrow, all of which are blue-black.

We do not believe that a heightened power to attract the dye is possessed by the cells in these localities. The skin cells in the neighborhood of a puncture take up the stain almost as rapidly, but they are unable to do it when the large dye particles are only circulating in the blood vessels, from which their lack of diffusion powers never take them, for they can not leak through the walls of the capillaries.

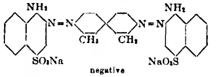
A glance at the list of positive and negative dyes which is just presented shows us that most positive dyes are disulfonic acids, a statement, in view of the ideas which we have just developed, which means that the sulfonic acid radicle exerts a favorable effect on the character of the dye solution, *i. e.*, makes it more soluble, more diffusible, and, so, quickly distributed, that is, *a true vital stain.* Evidence to this effect has already accumulated in a comparison with the positive and negative dyes 184, 185, 1846, 1824 and 1835, but this conclusion is, we think, substantiated in a more complete and overwhelming way by the sulfonation of a number of negative dyes by which means brilliant, positive stains were always secured. We cite as a good example of this

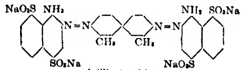

negative


positive


brilliant positive

Identical results were secured with the 2.8 amido naphtol 6 sulfonic acid combined with benzidine, with benzidine monosulfonic acid and with benzidine disulfonic acid; and a similar effect of sulfonation is seen in the brilliant tetra-sulfonic congo red dye made from the 1 naphtylamine 4.8 disulfonic acid, whereas the congo red monosulfonic acid (the 1 naphtylamine 4 sulfonic acid) or naphtionic acid yields a dye which is not a vital stain.


negative


brilliant positive

In this connection the question of whether or not it was possible to over-sulphonate the dye was attempted with interesting results. The sulfonation of diamine blue 2B gives us a dye which while a vital stain nevertheless passes the kidney much more rapidly than the original body, so that after an intense stain the animal is decolorized again in a few days. We have secured identical results in experiments with a similar sulfonated trypan blue.

The staining with acid azo dyes then is a physical phenomenon, and when we turned our attention to the likelihood of other solutions or pseudo-solutions giving an identical picture we are able to say that such is indeed the case, for those excellent suspensions of fine particles of gold, silver, palladium and some other metals which are called colloidal solutions eventually stained an animal just as did our vital dye. This effect has in fact been known for a long time for the so-called argyria, a pigmentation of the mucous membranes of workers concerned with silver salts, is a similar storage of particles formed by the silver when it meets the fluids in the body.

It remains now to discuss briefly what cells or tissues in the body are selectively affected by these stains. We can do this best by describing the autopsy of an animal which has been injected, on two occasions three days apart, with trypan blue and killed the day following the last injection when the animal with every appearance of health is intense blue. The skin of the abdomen when stripped back is seen to be intensely stained, but freshly spread preparations from the subcutaneous tissue show that the color is only to a minor degree due to the coloration of the fluids, but mainly to great numbers of small though dense granular deposits in certain cells. The larger and more striking of the cells possess a large slightly irregular oval nucleus, and an elongated cell body with frequent though always sharply defined pseudopodia or larger cell processes. Irregularly scattered through the cytoplasm are the granular deposits of the dye, and the larger of these are always comprised in a vacuole inside of which both larger and tinier fragments are in liveliest Brownian movement. We have identified these large, brilliantly stained cells of the skin and connective tissue of the body as the cells which have been designated variously by histologists as the resting wandering cells (Maximow); the clasmatocytes (Ranvier), the adventitia cells (Marchand) and the rhagiocrine cells (Regaud). At the same time in smaller, although more abundant cells, cells with more regularly oval nuclei and with faintly defined nuclear membrane and cytoplasmic boundaries, in these cells are fine scattered granules of the stain. These are, we believe, the most abundant and typical cells of connective tissue and are probably those designated as fibroblasts by the majority of investigators. None of the blood cells nor the endothelial cells of the capillaries of the skin carry the minutest trace of the dye. The muscles of the body, instead of their customary pink hue, are greenish in color, due to the infiltration in the minute connective tissue septa of countless numbers of these vitally stained cells of both types. The peritoneal cavity contains a normal amount of fluid which is pale blue in color and in which are suspended many vitally stained cells. The most brilliant of these and the largest are those cells which have been designated by Mechnikoff, Schott and others as makrophages—cells which, spherical in shape, are covered with delicate pseudopodia, and the cytoplasm of which is often a frothy mass of vacuoles, in which are always particles of the dye. We can trace all transition stages from these cells to those but slightly larger than lymphocytes, all of them containing some inclusions of the vital stain.

The cells which line the peritoneum, the mesothelial cells of Minot, possess in a peripheral zone the fine granulations which are characteristic of the cells of type 2 in the skin.

Of the peritoneal organs the liver and kidney are undoubtedly the deepest stained, for they are almost a blue black, a color due in the liver almost exclusively to the inclu-

sions of the dye by the cells of Kupfer of the hepatic capillaries and in the kidney to a similar behavior shown by the epithelial cells of the proximal convoluted tubules. The spleen and lymph glands are stained a paler though still brilliant blue and the color is due in these organs to the granules carried by the so-called reticular and by the true lymphatic endothelial cells.

In the testis the interstitial cells of Leydig are stained brilliantly, although the granules here are singularly regular and intermediate in size between those possessed by cells of type one and two in the skin. In addition, true vitally stained connective tissue cells of type two are also present between the seminiferous ducts, but the epithelial cells of the seminiferous tubules never contain the slightest trace of the dye.

The pancreas possesses in the connective tissue septa of its acini brilliantly stained cells of type one, although no particle of the dye is found in the pancreatic parenchyma.

The thoracic cavity presents a remarkable picture, for its deep blue walls enclose the lungs which have preserved their normal pink color, and in which few vitally stained cells are found. The heart, however, contains many of these, for not only do the epicardial cells receive the dye like the mesothelial ones, but also many connective tissue cells of type one infiltrate its musculature at many points.

The thymus, thyroid and parathyroids owe their generally lighter stain to similar cells which follow the connective tissue in its structural relation to these organs.

Most remarkable is the behavior of the central nervous system, for with the exception of the hypophysis and choroid plexus the nervous system contains no trace whatever of the dye, and its whiteness in contrast to the stain of the other tissues is a strange sight, the more so because the dura is always densely stained.

With the exception of the kidney, the epithelium of whose convoluted tubules comes from the middle germ layer, the great mass of the epithelium of the body refuses to react to the stain. Most remarkable also is the rejection of the dye by the blood cells, whose polymorphonuclear elements have always been supposed to play so great a rôle in phagocytizing foreign particles.

It might possibly be supposed from the comparative physical measurements we have made on the dyes that the so-called vital stains or vital granules, which we have just described, are an expression merely of diffusion, especially inasmuch as the most diffusible dyes of this class are the most satisfactory vital stains; but we have explicitly pointed out that heightened diffusion powers effect the vital stain merely by enabling the dye molecules or dye-molecular-complexes to present themselves to the class of cells which will receive them in every corner of the body. Having arrived at the cell, the dye by no means diffuses into it, as we can see, for instance, various basic dyes (neutral red, methylene blue, janus green) diffuse into a cell, advancing from periphery to center, and lodging often with special avidity in some preformed granule or structural element of the cell (*e. g.*, mast cell granules with thionin or neutral red, Nissl bodies with methylene blue). The benzidine dyes, let in more slowly at the cell's periphery, never encounter physical conditions which favor their rapid spread and they are disposed of by the cell by being concentrated at various points where they are doubtless set apart from the cell's protoplasm. The vital granules then deserve their designation, for they are always the result of the behavior toward the dye on the part of a living cell. Dead cells behave quite differently, for into their protoplasm, including the nucleus, the benzidine dyes diffuse rapidly, produc-

ing a uniform stain. Nothing is more striking than the way in which dead cells are stained in this manner. Liver cells selectively poisoned by chloroform[3] and renal cells killed by sublimate[4] both permit an immediate diffusion of the dye into them and resultant stain; and even the nerve cells, normally hostile to the entry of a single trace of the dye, receive it similarly when killed, an elegant example of which is furnished by the anterior horn cells in experimental poliomyelitis.[5] When we tap the cover slip over leucocytes swimming in trypan-blue, mechanical injury to the immediate subjacent cells invites instant entry of the dye.[5a]

It is evident then that into the dead cell a true diffusion takes place, but if diffusion be acting at all in the case of those living cells which react to the vital stain it is at least seriously hampered. There is in fact no reason for the identification of the vital stain with a diffusion phenomenon. It is significant that the cells which take the benzidine dyes are predominantly those endowed with powers of phagocytosis, a process long known to be operating in the case of particles from approximately 10 to 1 micron in size but it is not improbable that the colloidal particles of the benzidine dyes, whose dimensions must lie below a hundredth of such size, are received into the cell in an essentially similar way. Owing to their comparative minuteness, however, these particles are enabled to gain entry into many cells quite incapable of receiving larger ones. The fibroblast and mesothelial stains are examples of this. Yet in none of these cases does the cell, as it were, drink in the dye particles, as it does the freely diffusing ions of a salt solution. Nor indeed are the dye molecular-aggregates phagocytized in the usual acceptation of the term, for there is not merely a protoplasmic flow around a foreign body. Countless ultramicroscopic particles of the foreign body are let into the peripheral protoplasm and collected in the more central lying depots which we can at last recognize under the microscope as the dye granules.

This moving together or centralization of the dye in granules is not a reaction peculiar to the dyes, for an identical phenomenon is seen when colloidal silver is used, in which the particles have dimensions also considerably below the limits of ordinary microscopic vision and far below the dimensions of the intra-cellular granules in which they are later agminated.[6] Yet we have never hesitated to speak of the phagocytosis of silver aggregates in this later case.

We have to do then, in the case of cells which are stained vitally by these dyes, with a great host of elements scattered all over the body, serving in some special organs as the lining of blood and lymph vessels, but in the great interstitial tissue of the body without the vessels, equally abundant, cells whose primary function seems to be the engulfment of particles whose physical dimensions fall within certain limits. These scavenger cells, as it were, rid the blood and tissue juices of many kinds of useful and unuseful débris. How they do this may still be difficult to explain, but there seems no doubt but that their protoplasm in contrast to that of epithelial cells consists of a peculiar physical system.

[3] Experiments with Dr. Samuel J. Crowe, as yet unpublished.

[4] Gross, *Beitr. z. path. Anat.*, Bd. 51, p. 528, 1911.

[5] MacCurdy and Evans, *Berliner Med. Woch.*, 1912, No. 36.

[5a] Evans and Winternitz as yet unpublished.

[6] Bechold (*Zeitschr. f. chemie und Industrie der Kolloide*, 2 Jhrg., heft 1, 2) has determined that the aggregates of collargol-Heyden have a diameter of 20 $\mu\mu$. They consist of aggregates of metallic particles and particles of the schutz-kolloid together.

That useful and unuseful débris occurs normally in the body needs not, we take it, be defended, for the continual breaking down of some cellular elements of short life, the red blood corpuscles, for example, set free substances whose physical dimensions enable them to be engulfed by many of the cells which we have described (occurrence of blood pigment in liver, spleen, lymph glands and bone marrow) but that this reaction needs by no means be considered as one adapted for the engulfment of bodies of this class is proven conclusively by a number of observations made very recently by Ciaccio and others which go to show that fatty acids and lipoid substances are stored by the same cells. We are concerned then with cells of great physiological importance to the organism, cells whose action in this capacity, we believe, seems proven to be conditioned by physical and not chemical forces of response.

Herbert M. Evans,
Werner Schulemann

COMPARATIVE REGISTRATION STATISTICS[1]

One of the greatest difficulties encountered in the compilation of comparative university statistics is found in the apparent impossibility of securing uniformity. This difficulty is owing in large measure to two factors, one quantitative and the other qualitative. An illustration of the former is furnished by the fact that the student attending six weeks of summer session is recognized as a full unit, just as much as the student of an engineering school who annually puts in thirty-six hours a week for two half-years and several weeks in camp; and similarly a person engaged in secondary teaching who registers for a single late-afternoon or Saturday morning course counts as a full unit just as well as a candidate for the doctorate who spends his entire time at the university. Again, there are the students in so-called short courses, in agriculture, for example, who receive as much recognition as those who spend the entire year at the university. As a matter of fact, the most satisfactory solution along this line would be found in adopting a student-hour unit, but this, from the very nature of the case, would be an extremely complicated procedure. A simpler solution is reached by separating the summer session and short course students from those attending the entire year, and similarly by separating the full time from the partial time students. A difficulty would arise in connection with the point at which the line between these two groups is to be drawn, but this could readily be adjusted by agreement between the institutions involved. In this connection it might also be pointed out that owing to the fact that many secondary schools graduate classes in January as well as in June, several colleges and universities are admitting new students in February; they spend only half a year at the institution, but are counted as full units. On the other hand, the number of regular students enrolling for work in the summer session in order to reduce their time of residence or to make up conditions is constantly on the increase.

So far as the qualitative distinction is concerned, it must be borne in mind that the size of a university gives no more indication of its efficiency than the population of a country does of its degree of civilization, or the size of a city does of the morals and social welfare of its inhabitants. Comparative registration statistics, as they have been published by the writer from time to time in Science and elsewhere, have therefore little qualitative significance, inasmuch as such items as standards of admission and advancement, efficiency of instruction, equipment, and the like, are necessarily ignored in the comparison. So far as we are concerned in the present instance, standards of admission constitute perhaps the most significant item. No student should, in my opinion, be counted in the enrollment of a university, who has not offered graduation from a secondary school for admission. For-

[1] Paper presented at the annual meeting of the American Association of Collegiate Registrars, Richmond, Va., 1914.

tunately the admission requirements in this country, owing to the influence of the Carnegie Foundation, the Association of American Universities, the American Medical Association and similar organizations, are being rapidly increased all along the line, but courses are still offered at several universities in which high-school graduation is not demanded for admission. The students registered in such courses should be rigidly excluded in the university total, but it is not always an easy matter for the outsider to determine who these students are, and consequently our sole dependence lies in the cooperation of the reporting officers of the institution concerned. Of less importance, though not entirely without significance, is the difference that still exists in entrance requirements for the professional schools, several of which insist upon a bachelor's degree, while others are still satisfied with high school graduation. It would seem that a student in a medical school who holds a bachelor's degree would have greater qualitative value, other things being equal, than one who has entered the school directly from the high school. The adoption by so many institutions of the so-called Columbia or combined-course plan, in accordance with which six years are devoted to work for the bachelor's and the professional degrees, is bringing about a certain amount of uniformity in this direction. Yet even where college graduation is demanded for admission to the professional schools, and more particularly to the nonprofessional graduate schools (political science, philosophy, pure science), some difficulty is encountered, inasmuch as the bachelor's degrees of American colleges are unfortunately not of equal value, and for that reason a number of graduate schools do not accept graduation from certain specified colleges for admission. This is a matter which only time can remedy, and fortunately there are indications that the work of these inferior institutions is slowly but surely improving. Comparative statistics of the professional schools showing the percentage of college graduates enrolled in these schools are therefore of distinct value.

A word should be said concerning the inclusion of extension students in the grand total enrollment of a university. As a matter of fact, extension students are frequently, quantitatively as well as qualitatively, on a par with summer-session students. They are, in many instances, at several institutions in most instances, graduates of high schools following work of college or university grade given by regular officers of the institution concerned, and there seems to be no reason why an extension student registered for a graduate course in literature should not be counted in the university's total with as much justification as the high school teacher who is enrolled as a candidate for the master's degree but attending only a single Saturday morning course. On the other hand, extension students are from the very nature of the case practically all partial-time students, and for this and several other reasons it is safer perhaps to keep them in a category by themselves. Auditors in attendance on a six-hour lecture course should not be included at all, as they sometimes are.

Considerable difficulty is constantly experienced in prevailing upon reporting officers to eliminate the item of double registration. The ideal table of comparative registration statistics would simply ignore this item; where it is not ignored, an element of unfairness is at once introduced. The student should be considered primarily registered in one faculty only, and if he happens to be enrolled in a combined course, he should, for example, in his third and fourth years as a candidate for the bachelor's degree, which coincides with the first and second years of his candidacy for the medical or engineering degree, be counted either as a college student or as a medical or engineering school student, but not, as is frequently done, as both. The latter method unduly swells the size of the individual faculties of the institution. Similarly, the students at Columbia University enrolled as candidates for the master's or the doctor's degree and with the major subject in education should be included either in the faculty of philosophy or in Teachers College, but not in both. In

such cases a footnote can readily be added calling attention to the actual state of affairs. Where the enrollment at a summer session is included, the item of double registration giving the number of students in attendance on the summer session who returned for work in the fall is of course unavoidable.

So far as the individual tables of statistics prepared by the office of the registrar are concerned, I consider the geographical distribution figures as among the most valuable, especially in view of the fact that these are not prepared by the Commissioner of Education. In the preparation of these statistics it should be borne in mind that students are often inclined to enroll from the town or state in which the institution in question is located, instead of from their actual home. A distinction should be drawn, for example, between the Chinese student who spends four years in this country and returns to his native land, and the student from Germany who enters one of our professional schools and contemplates remaining in this country. Statistics of birth are also valuable, although rarely compiled. This applies also to statistics indicating the vocations of the students' fathers.

In connection with tables illustrating changes in enrollment covering a period of years, attention should also be called to the *percentage* of increase (or decrease), which is usually more valuable in connection with comparative statistics than a mere statement of growth in student units.

So far as tables illustrating specific items of registration are concerned, I would respectfully recommend the suggestive tables and diagrams included in the recently published annual report of the registrar of the University of Illinois, which possess the merit of simplicity and clearness.

In my opinion the wide distribution of university statistics is just as valuable as the dissemination of statistical material compiled by the census office, only it must always be borne in mind that in connection with an educational institution size is by no means a primary consideration. Entirely as much fault may be found with an overgrown department, school or university, as with an overgrown boy, city or potato. It is always necessary, in the case of comparative figures, to read between the lines, although there is no doubt of the fact that not infrequently the large enrollment in a particular school is due to the well-deserved reputation which this school enjoys, as witness the Harvard Law School, the Johns Hopkins Medical School and the Columbia Graduate School. Any attempt, however, especially on the part of overzealous alumni, to overemphasize size at the expense of efficiency, should be deplored. In this connection the following paragraph in the last annual report of President Butler will be of interest:

> The popular mind is easily impressed with size, and particularly with large numbers. The fact that Columbia University has under its influence and instruction many thousands of students is annually heralded in the public press as entitling it to claim precedence over other institutions at home or abroad. Within the university itself no such feeling prevails. The growth in numbers so marked in recent years, is, of course, gratifying in so far as it indicates that the curriculum, the equipment, and particularly the teachers and investigators of Columbia are sought on their own account. But we deplore growth in numbers unless it were accompanied by a steady increase in the quality of the students. . . . What should concern us is the quality, the character and the homogeneity of the several units of which the total is composed.

Rudolf Tombo, Jr.

Columbia University

ARTHUR HENRY PIERCE

Arthur Henry Pierce, for fourteen years professor of psychology at Smith College, died of pneumonia, after a brief illness, on February 20, at Northampton, Mass. He was born in Westboro, Mass., July 30, 1867. He graduated at Amherst in 1888 and for two years thereafter taught mathematics in the college. His post-graduate studies in psychology were pursued at Harvard, where he received the master's degree in 1892 and the doctor's degree in 1899, and at the universities of Berlin, Strassburg and Paris, which he frequented in the years 1894–1897. He was the first holder

of the Kellogg University Fellowship, his tenure of which lasted from 1894 to 1900. In 1900 he was appointed professor of psychology in Smith College. He was an active member of the American Psychological Association, being for three years its secretary (1908–1910) and for another three years a valued member of the council (1911–1913). For the past four years he was editor-in-chief of the *Psychological Bulletin*. His first contribution to psychological science was an investigation on phenomena of attention conducted in collaboration with J. R. Angell in the Harvard laboratory and published in 1892. Two years later he published a paper on the localization of sound. For several years he made a careful study of geometrical-optical illusions. The results of these researches were collected into a volume, the "Studies in Auditory and Visual Space-Perception," published in 1901. Since then his attention as a psychologist was largely given to phenomena of dreams, hypnotism, subconsciousness and synesthesia, in which field the most important of his publications was the noteworthy paper entitled, "An Appeal from the Prevailing Doctrine of a Detached Subconsciousness," published in the Garman memorial volume in 1906.

Arthur Pierce was a man of singular breadth, balance and clarity of mind, of equable temper and of rare personal charm. All his work as teacher, investigator and administrator was marked by thorough conscientiousness and careful attention to details. His cheerful disposition, his unvarying courtesy, his quick, yet unobtrusive, sympathy, his resourcefulness and his practical good sense made him universally admired and beloved and his loss will be deeply and widely felt not only by his psychological colleagues, but by many in diverse walks of life who counted him as a loyal friend.

H. N. G.

THE FAIRPORT BIOLOGICAL STATION

THE biological laboratory of the United States Bureau of Fisheries, Fairport Station, will be opened for general biological investigations in the early part of the coming summer. This is the first permanent laboratory established by the government for the special study of freshwater biology and problems relating to freshwater fishery resources. The station is located on the Mississippi River twenty miles west of Davenport and eight miles east of Muscatine, Iowa, on the main line of the Rock Island railway between Chicago and Kansas City. Chicago, Milwaukee and St. Paul Railway trains from Chicago to Kansas City also pass through Fairport, using the Rock Island tracks.

The Fairport station was established by Act of Congress for mussel propagation and biological investigations. It has been in construction for several years, during which period the permanent staff of the station and a few associates have been engaged, apart from the propagation work, in experiments and other forms of investigation, both at the station and in the field in various parts of the Mississippi basin. Small temporary quarters were occupied.

The permanent laboratory building, which is about 50×100 feet, was constructed last year, and it is now largely equipped and ready for summer occupancy. The two main stories of the laboratory building comprise a general laboratory, and several smaller special laboratories, a library, storeroom, offices and six bed-chambers. On the third floor are additional bed-chambers and storage compartments, while the dining-room and kitchen are located in the basement. The building is supplied throughout with filtered water from an underground concrete cistern on the hillside.

On the grounds below and above the railway are ten earth ponds, the largest of which is an acre and a quarter in extent, and fourteen small concrete-lined ponds of different forms and depth. There is also a tank house, twenty-five by fifty feet, in which are various tanks and troughs. The ponds and the tank house are supplied with unfiltered river water drawn by gravity from a storage basin holding about two million gallons. The pumping equipment consists of three steam-turbine-driven pumping units of a maximum pumping

capacity of about three million gallons per day. An artesian well on the grounds near the river offers a limited flow of hard water, which is not stored.

The grounds comprise sixty acres of cleared and wooded land, mostly with a gentle slope, and extending from the banks of the river to the top of the bluffs. The river frontage is about a quarter of a mile.

The station has two launches and a number of rowboats, with one portable Evinrude motor. A fishing crew is engaged almost daily. Opportunities are, therefore, offered for collecting in the various parts of the river or in the lakes and slues which are found in the islands and the lowlands of the Illinois shore. Interesting aquatic environments are also presented by the ponds on the station grounds, which are generally very rich in plankton.

The laboratory will not only be used by the permanent staff and associates of the bureau engaged on special problems, but it is desired to extend the facilities of the institution to other investigators desiring to study problems for which the conditions at Fairport may be particularly favorable.

The laboratory is furnished with the ordinary glassware and scientific apparatus. No charge will be made for occupancy of tables or dormitory rooms, but the mess will be operated upon a cooperative plan, each participant sharing in the expense. Further conditions and information will be supplied upon request.

Since only a limited number can be accommodated in the first season, it is requested that applicants for tables address the Commissioner of Fisheries, Washington, D. C., or the director of the biological station, Fairport, Iowa, as early as practicable. Investigators requiring the use of special or unusual apparatus should communicate particularly with the director, in order that they may be informed as to the special equipment of the station related to their needs.

Robert E. Coker,
Director

March 2, 1914

A NATIONAL ASSOCIATION OF UNIVERSITY PROFESSORS

In the spring of 1913 a circular letter, signed by most of the full professors of the Johns Hopkins University, was sent to members of the faculties of nine other universities, inviting them to consider the advisability of the formation of a national association of university professors, and to send delegates to an informal conference for the discussion of the matter. The letter contained the following statement of the reasons actuating the signers of it:

> The reasons which seem to demand the formation of such an association are fairly evident. The university teacher is professionally concerned with two distinct, though related, interests. Both of these interests can be furthered by cooperation and the interchange of views, and therefore, by organization; for only one of them has suitable organization yet been attained. As scholar and investigator the teacher is interested in the advancement of learning and the diffusion of knowledge in his specialty; and cooperative effort for these ends is already effectively organized, through our numerous technical societies and the several sections of the American Association. But the university professor is also concerned, as a member of the legislative body of his local institution, with many questions of educational policy which are of more than local significance; he is a member of a professional body which is the special custodian of certain ideals, and the organ for the performance of certain functions essential to the well-being of society; and concerning the character, efficiency, public influence and good repute of this body he can not be indifferent. It is on this side that there is need for more definite and more comprehensive organization. The general purposes, therefore, of the contemplated association would be to promote a more general and methodical discussion of the educational problems of the university; to create means for the authoritative expression of the public opinion of the profession; and to make possible collective action, on occasions when such action seems called for.

A favorable response was received in all cases, and statements expressing the belief in the desirability of the formation of such an association were drawn up and signed by members of the faculties of most of the uni-

versities addressed. The proposed conference was held in Baltimore on November 17, 1913, on the eve of the annual meeting of the National Academy of Sciences. It was attended by eighteen delegates, from the following universities: Clark (Professors Taber and Webster); Columbia (Professors Cattell and Dewey); Cornell (Professors Bennett and Nichols); Harvard (Professor Minot); Johns Hopkins (Professors Ames, Bloomfield, Lovejoy, Morley); Princeton (Professors Capps, Kemmerer, Warren); Wisconsin (Professors Cole, Marlatt), and Yale (Professors Harrison, Mendel). After prolonged discussion of the whole subject it was unanimously voted that the organization of the proposed association should be undertaken; and the chairman, Professor Bloomfield, was authorized to appoint a committee, representing the principal subjects of study and the principal universities, (*a*) to determine what professors, or classes of professors, should be invited to attend a meeting, to be held at some time during the current year, for the formal establishment of the association; (*b*) to determine the time and place of this meeting, and (*c*) to prepare a draft of a constitution. After some unavoidable delays, the chairman of the conference has announced the composition of the committee as follows: Astronomy, George C. Comstock (Wis.); Biological Sciences, E. G. Conklin (Princeton), R. G. Harrison (Yale) and Theodore Hough (Virginia); Classical Philology, E. Capps (Princeton); Chemistry, Julius Stieglitz (Chicago); Economics, M. A. Aldrich (Tulane), Alvin S. Johnson (Cornell); Education and Psychology, John Dewey (Columbia); Engineering, Guido Marx (Stanford); English, J. W. Bright (Johns Hopkins), C. M. Gayley (California); Geology, W. H. Hobbs (Mich.); Germanic Philology, M. G. Learned (Penn.); History, W. E. Dodd (Chicago); Law, Roscoe Pound (Harvard); Mathematics, C. J. Keyser (Columbia), Henry Taber (Clark); Medicine, C. S. Minot (Harvard); Oriental Languages, Morris Jastrow (Penn.); Philosophy, A. O. Lovejoy (Johns Hopkins), Frank Thilly (Cornell); Physics, C. E. Mendenhall (Wis.); Political Science, Isidor Loeb (Missouri); Romance Philology, F. M. Warren (Yale). Professor Dewey has consented to act as chairman.

In selecting the members of this committee of twenty-five, the chairman of the conference has, of course, had in mind three criteria: the representation of the principal universities, the representation of the several sciences, and the special qualifications of individuals for service upon such a committee. With very few exceptions those first asked to serve upon the committee have readily agreed to do so. In two or three instances, however, it has been necessary to leave important universities thus far unrepresented, owing to the inability of the professors first invited to serve, and the inexpediency of further delaying public announcement of the committee's membership until other representatives of those institutions could be selected and notified, and their acceptances be received. The committee may be expected to begin at once the consideration of the questions submitted to it; and it will doubtless be able to announce the date of the contemplated meeting, and its general proposals with respect to the association, within a few months.

SCIENTIFIC NOTES AND NEWS

THE College of Physicians of Philadelphia, the American Philosophical Society, the Library Company of Philadelphia, the Jefferson Medical College and the Academy of Natural Sciences have arrange a memorial in honor of the late Dr. S. Weir Mitchell, to be held on the evening of March 31, in the Hall of the College of Physicians. Addresses will be delivered by Dr. Talcott Williams, New York City; Dr. William H. Welch, Baltimore, and Mr. Owen Wister, Philadelphia.

DR. CHARLES W. ELIOT, president emeritus of Harvard University, celebrated his eightieth birthday on March 20.

A PORTRAIT of Dr. James Ward, professor of mental philosophy at the University of Cambridge, by Mr. Ambrose McEvoy, has been presented to the university.

The University of Cambridge proposes to confer on the occasion of the opening of the new physiological laboratory on June 9 the degree of doctor of science on Sir William Osler, Sir David Ferrier, Sir E. A. Schäfer and Professor E. H. Starling.

The opening ceremonies of the Institute for Medical Research, founded with an endowment of $1,000,000 by Mrs. George William Hooper in memory of her husband, were held on March 7 at the University of California Hospital, San Francisco. Addresses were made by Dr. Henry S. Pritchett, of the Carnegie Foundation, on "The Value of Medical Research to a Great City," and by Dr. Richard Mills Pearce, Philadelphia, on "The Opportunity of the University in Medical Research."

The Vienna Prehistoric Society was recently founded with Professor Moritz Hoernes, of the University of Vienna, as its president.

On the occasion of the thirtieth anniversary of the Circolo Matematico of Palermo a gold medal will be presented to Dr. Giovanni B. Guccia, founder of the society and editor of its publications.

The Hon. Bertrand Russell, of the University of Cambridge, has taken up his duties at Harvard University during the second half-year.

Professor Charles E. Bessey, of the University of Nebraska, is spending the month of March at the Desert Botanical Laboratory of the Carnegie Institution near Tucson, Arizona. Professor Bessey plans to study and collect material of numerous species of the desert flora. While he is away Dr. R. J. Pool is in charge of the department of botany at the University of Nebraska.

Professor William T. Sedgwick, head of the department of biology and public health at the Massachusetts Institute of Technology, has been given leave of absence for the present term, on account of a recent illness. He will pass the time in southern Europe.

Mr. Frank Alvord Perrett, the American volcanologist, has been slightly burned on the hands and legs by an explosion of molten lava while studying the volcano of Sakura-Jima.

A testimonial dinner was tendered to Dr. Samuel Sheldon at the Hotel Astor on March 21 to celebrate a quarter of a century of service as professor at the Polytechnic Institute of Brooklyn.

The members of the Chemists' Club, New York, gave a complimentary dinner to Dr. Wolfgang Ostwald, of the University of Leipzig, on March 19.

Mr. Emil Huber-Stockar, engineer in charge for the Swiss government of the electrification of the Gothard tunnel and president of the Swiss national committee of the International Electrotechnical Commission, was a guest of honor at a dinner given at the Engineers' Club, New York City, on March 13, by Mr. C. O. Mailloux, president of the American Institute of Electrical Engineers.

Professor George Grant MacCurdy, of Yale University, has been elected a corresponding member of the Numismatic and Antiquarian Society of Philadelphia.

Mr. François E. Matthes, associate geologist of the U. S. Geological Survey, has been elected a corresponding member of the International Glacier Commission.

Professor H. H. Norris, until last year professor of electrical engineering in Cornell University, has accepted an appointment as associate editor of the *Electric Railway Journal*, and, beginning on July 1, when his term as secretary of the Society for the Promotion of Engineering Education expires, he will devote his entire time to that publication.

Carl Spencer Milliken has been appointed assistant superintendent of Agricultural Extension in the University of California, with headquarters at the Graduate School of Tropical Agriculture at Riverside.

Dr. Henry Norris Russell, professor of astronomy in Princeton University, lectured before the Columbia Chapter of Sigma Xi on March 24, the subject being "Eclipsing Variable Stars."

Professor Roswell H. Johnson, of the University of Pittsburgh, lectured before the department of geology of Columbia Univer-

sity on March 24 and 26, the subjects of his lectures being "The Origin of Petroleum and Natural Gas, New and Old Theories" and "Proposed Methods of Securing an Increased Yield from Oil-wells."

Professor Arthur W. Goodspeed, of the University of Pennsylvania, lectured at Bucknell University on March 13 on "Radioactivity with Special Reference to Radium."

Professor F. E. Lloyd, of McGill University, recently gave a lecture before the Ottawa Field Naturalist's Club on the subject of "Abscession in Flowers, Fruits and Leaves."

Professor George Grant MacCurdy, of Yale University, completed on March 10 a tour of the eastern Canadian circuit, where he lectured on "The Dawn of Art" by invitation of the Archeological Institute of America at St. John, Halifax, Quebec, Montreal, Ottawa, Toronto and Hamilton.

Adolph Francis Alphonse Bandelier, a distinguished authority on South American archeology, lecturer in Columbia University, died in Madrid, Spain, on March 20, aged seventy-four years.

Dr. W. T. Dutton, professor of mathematics and civil engineering at Allegheny College, in Meadville, Pa., has died at the age of sixty-two years.

Professor Giuseppe Mercalli, director of the Mount Vesuvius observatory, and professor of vulcanology and seismology in the University of Naples, has died at the age of sixty-four years, having been burned by the overturning of a lamp, or perhaps murdered.

Dr. Edward C. Pickering, director of the Harvard College Observatory, has sent under date of March 10, the following bulletin:

The following statement has been received from Professor W. H. Pickering, in charge of the Mandeville Station of this observatory: Attention was called to the lunar crater, Einmart, in A. N. 4704. It is there stated that its interior was very brilliant in January, 1913, but since March had been very much darker. This darkness persisted throughout the remainder of the year, and through January of this year. In February, however, it again brightened up, being about as bright as it was in February, 1913, though by no means as brilliant as in January of that year. As it is a large crater, 25 miles in diameter, the brightness of its interior may be easily observed, even with a small telescope and under unfavorable atmospheric conditions. This past month it has been clearly brighter than any area of similar size between it and the limb. This had not been the case since the previous March. In the preceding January it was the brightest area of that size visible at that time upon the Moon. All observations should be made immediately following the first quarter. The interior is full of fine brilliant detail, constantly varying, not only from night to night, but also from month to month. This observation is, however, probably too difficult for any northern telescope, since it requires not merely one, but a succession of fine nights.

There is in the Paris Museum of Natural History a skull, which, according to tradition, once enclosed the brain of Descartes. The *British Medical Journal* says that the Academy of Fine Arts recently invited Dr. Paul Richer, professor of anatomy in the Paris School of Fine Arts, and a member both of the Academy of Medicine and the Academy of Fine Arts, to compare by scientific methods, in collaboration with M. Gaston Darboux, the supposed skull of Descartes with the different portraits of the famous philosopher. Dr. Richer indicated on a plaster cast given him by the museum certain distinctive characters which are well marked on the head of the portrait painted by Franz Hals. It is said to be on these resemblances that Cuvier based the opinion that the skull is authentic, which he expressed in 1821. He next drew a skull, as closely adapted as possible, resembling that outlined in the portrait. Then he made a drawing of the museum skull posed with the same orientation and on the same scale as the head of the portrait. Lastly, he superimposed the two drawings. In his first drawing Dr. Richer marked certain points—at the root of the bones of the nose, on the external orbital apophyses, and on the nasal spine. These same points were repeated on the cast of the skull in the museum. By means of these marks it was easy to place with almost mathematical precision the skull in the posi-

tion which Hals had given his model. The superimposition of the two drawings showed an almost absolute agreement. On the other hand, other drawings made under the same conditions of several skulls taken at random, showed notable discrepancies. The same experiment was repeated with the other portraits of Descartes, namely, that by Sebastian Bourdon in the Louvre; that of Beck, of which there is a copy in the library of the institute, the terra cotta medallion of the Versailles Museum, and an old portrait by an unknown painter belonging to M. Rulhe, of Courvevoie. The comparison of the skulls in these different portraits with that of the museum shows some striking resemblances, but never so complete an agreement as was found with the Hals portrait. Before Dr. Richer began his investigation much the same procedure was employed by Dr. Verneau, professor of anthropology at the museum, who came to the same conclusion. As a matter of history it is known that the skull was detached from the philosopher's body in 1666 by Israel Planstrom, Captain of the Queen of Sweden's Guards, and it was given to the French nation by Berzelius. Now that the relic has been satisfactorily identified, it is suggested that it should be placed in the coffin which contains the decapitated skeleton of the philosopher. This is in the Church of Saint Germain des Prés, where it lies in one of the chapels between the remains of Mabillon and those of Montfaucon. Another suggestion is that the skeleton and skull might be solemnly transferred to the Pantheon in accordance with a decree of the Convention of October 2, 1793, to which effect was never given. At a meeting of the Académie des Sciences on January 20, Professor Edmond Perrier declared that the identification having been made conclusively, it was no longer right that this relic of the great thinker should be left amidst the collections of the gallery of anthropology and paleontology in the museum. He undertook to have a kind of reliquary constructed in one of the rooms of the museum where there are already relics of other famous men. There the skull of Descartes will be deposited, together with the documents establishing its authenticity.

UNIVERSITY AND EDUCATIONAL NEWS

Tentative plans for buildings to replace the burned College Hall of Wellesley College provide for a quadrangle, including four buildings, on the old site. It is expected that the college will be able to reopen on April 7.

Amherst College has received a bequest of $5,000 for a scholarship under the will of Addison Brown, late of New York, and a non-graduate of the class of 1852.

Under the will of the late Dr. Rosewell Park the medical department of the University of Buffalo will receive his entire medical library of about three thousand volumes.

The valuable psychological library of Dr. Arthur Henry Pierce, late professor of psychology at Smith College, has been given to the college.

It is said that the secretary of the interior has written to the chairman of the house committee on education expressing disapproval of the bill to establish a national university.

The first structure that the Massachusetts Institute of Technology has erected for its own uses on its site in Cambridge is the new aerodynamic laboratory. The building is finished and the apparatus is in process of installation. The portion of its equipment that is first to be installed is the four-foot wind tunnel with its accompanying blower. This is of the pattern now in use at the National Physical Laboratory at Teddington, England, which has furnished the plans.

It is expected that a school of fisheries will be established at the University of Washington. If the plans mature, the resulting school will be the first school of its kind in the United States, though there are such schools in Japan and other countries.

Professor Frederick Slocum, who for the past four years has been in charge of the solar observations and stellar parallax work at the Yerkes Observatory, has been elected professor

of astronomy at Wesleyan University, Middletown, Conn., and will assume his new duties in the autumn. A new observatory will be erected immediately as a memorial to the late Professor Van Vleck, for many years in charge of that department at Wesleyan.

Dr. William C. Alpers, formerly a trustee of the College of Pharmacy of Columbia University, has been appointed dean and professor of pharmacy of the pharmaceutical department of Western Reserve University.

Mr. Robert N. Hoyt, '09, has been appointed by the corporation of the Massachusetts Institute of Technology special lecturer on public health administration.

Mr. Searcy B. Slack, B.S., Georgia, '11; A.M., Harvard, '12, has been appointed adjunct professor of civil engineering and road expert at the University of Georgia.

Professor Burton H. Camp, who has been associate professor of mathematics at Wesleyan University, has been advanced to a full professorship.

Dr. Ellis M. Frost, instructor in clinical medicine and microscopic anatomy in the School of Medicine, University of Pittsburgh, has been appointed to the position of director of the department of health of the university.

DISCUSSION AND CORRESPONDENCE

SMALL AERIALS AND THE STRENGTH OF WIRELESS SIGNALS

Few persons realize the ease with which wireless signals, such as are sent from the Navy station at Arlington, Va., and Sayville, Long Island, may be intercepted and read, even when one is some distance from the sending station.

In connection with some experiments on the effect of foliage, humidity, etc., on the strength of the wireless signals sent from the government station at Arlington, the writer was impressed by the large amount of power intercepted by an aerial erected on the university campus and an attempt was made to see if these signals could be read with a much less pretentious aerial. During the writer's summer vacation spent near Morgantown, W. Va., on the banks of the Monongahela River, a T aerial consisting of two No. 18 wires, 100 feet long, was stretched up between two trees on the side of a hill at the back of the camp. This aerial was approximately 30 feet high and 50 feet from the top of the hill. There were quite a few trees in the neighborhood of the aerial and in most cases they extended well above the highest point of the aerial. Some difficulty was met with in trying to find a satisfactory ground connection, but as soon as that was secured the "time signals" could be heard very clearly even in the brightest sunshine and on the warmest days of last August.

Upon the writer's return to Morgantown he found that not only the "time signals" from Arlington but the Sayville Long Island press dispatches could be heard with a T aerial consisting of three No. 18 wires, 30 feet long, fastened to the rafters in the attic of his residence. Later experiments showed that both these signals could not only be heard, but were loud enough to be read by using an ordinary iron bed with a wire soldered to the middle of one side for the aerial. The bed was located on the second floor of the house and was about 12 feet above the level of the street.

The receiving apparatus consisted of a Navy type of loose-coupled receiving transformer, a variable condenser, a silicon detector used without batteries and 1,000-ohm telephone receivers. A gas pipe leading to a gas stove in the room served as the ground line.

Morgantown is 162.3 miles from Arlington, Va., and 374.6 miles from Sayville, Long Island, with both the Blue Ridge and the Allegheny Mountains between. The peaks of some of these mountains rise as high as 2,200 feet above the top of the writer's residence and for the most part are covered with forests. In view of the distance from the sending stations and the mountainous character of the country over which these signals are transmitted the results obtained with these low and small aerials seem to warrant this brief description.

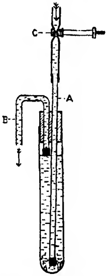
C. W. Waggoner

West Virginia University,
Morgantown, West Virginia

A SIMPLE APPARATUS FOR WASHING SMALL AND DELICATE OBJECTS FOR SECTIONING

The apparatus here described was devised for washing small and delicate objects fixed in Flemming-fluid. It has been found successful and economical for washing with distilled water also.

The apparatus consists of a *round-bottomed* glass tube, six inches long and one inch in diameter, a double-bored, tightly fitting stopper,[1] through which the inlet tube *A* and the U-shaped outlet tube *B* pass.



The inlet tube *A* should be inserted at a slight angle so that its lower end lies in the center of the round-bottomed tube within half an inch of the bottom. This end is covered with a piece of fine bolting-silk fastened with a rubber band. The bolting-silk breaks the force of the inflowing water, but more especially prevents the entrance of any foreign substance which might close the outlet. The upper end of tube *A* is connected by a rubber tube to the distilled water reservoir or faucet. The flow of water is regulated by screw compressor *C*.

The outlet tube *B* has its inner arm a trifle longer than the outer arm, so that the U does not act as a syphon. The inner arm of this tube is covered with bolting-silk also, to prevent the escape of any material which may float.[2]

With the water merely dripping, a liter per hour, the material is kept in constant motion and thoroughly washed.

S. I. Kornhauser

[1] The stopper and small tubes must fit tightly to maintain an air chamber between the stopper and the lower end of tube *B*.

[2] If the objects to be washed tend to float, a disk of perforated celluloid through which the inlet tube passes may be placed about an inch from the bottom of the larger tube.

THE CORRESPONDENCE OF LINNAEUS

To the Editor of Science: Dr. J. M. Hulth, of the University Library of Upsala, who has succeeded to the editorship of Carl von Linné's correspondence, formerly edited by the late Professor Th. M. Fries, desires information as to the whereabouts of letters to and from Linné which might be found in collections in this country. Individuals or institutions having such letters are asked to communicate with the undersigned.

Aksel G. S. Josephson

The John Crerar Library,
Chicago, Ill.

EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY

To the Editor of Science: The Royal Photographic Society of Great Britain are holding their fifty-ninth annual exhibition in August and September of this year. This is the most representative exhibition of photographic work in the world, and the society is anxious to make it more international in character. It is very desirable that American scientific photography should be fully represented at the exhibition, and in order to enable this to be done with less work to the exhibitor, I have arranged to collect and forward American work intended for the scientific section.

This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should reach me not later than Friday, July 10. They should be mounted but not framed.

I should be glad if any worker who is able to send photographs will communicate with me as soon as possible so that I might arrange for the receiving and entry of the exhibit.

C. E. K. MEES

RESEARCH LABORATORY,
KODAK PARK,
ROCHESTER, N. Y.

SCIENTIFIC BOOKS

Definitions in Physics. By KARL EUGEN GUTHE, Ph.D., Professor of Physics in the University of Michigan and Dean of the Graduate Department. New York, The Macmillan Company. 1913. Pp. vii + 107.

A man's convictions are vastly more important than the logical processes by which he reaches them; and his convictions are represented in a large degree by the definitions which he adopts. It follows, therefore, that the appearance of a volume of definitions by a scholar of high standing in any particular field of thought is a matter of some moment. There is danger of taking physics too seriously; and nothing is easier than to employ definitions in such a way as to produce in the student-mind what Professor Franklin calls "a stress of dryness." But when the technical terms of his own science have been collected by a well-known specialist they become a matter of keen interest, and all the more so when that specialist is an experienced and successful teacher as is Professor Guthe.

Definitions grow as our ideas grow. They are not the fixtures of the Medes and Persians. Compare the modern definition of the crab with the classical one given in the French Academy's dictionary. Or consider how the resistance term in Ohm's law developed into impedance upon the introduction of alternating currents. Previous to the renaissance forces were defined only in a statical way; anything that would flatten out the muscles of the hand, bend a beam, disturb the configuration of a steelyard, or bring out any other strain requiring work was classified as a *force;* and conversely the term *force* was used at that time to include many ideas, such as *speed, impulse, energy* and *power,* which now lie quite without its limits. Shortly after the renaissance the concept of force was enlarged so as to take in the time-rate of change of momentum; later the generalized forces of Lagrange are included. Again the Peltier effect is defined quite differently from what it was before the Thomson effect was discovered.

A list of definitions is therefore a list of variable quantities and can hardly be regarded as more than a cross-section of the conventions agreed upon by the generation which uses them.

The book under review is one which can not fail to be of the utmost help to any student of general physics. The definitions are arranged under the classical five chapters of physics. Each quantitative concept is, as a rule, first defined in simple English and in terms already explained or assumed; next follows a mathematical expression which may be considered as a repetition of the first definition, and frequently, as an expression of natural law. The definitions are remarkable for their clearness, simplicity and brevity; if at any point indefiniteness suggests itself one feels that additional details have been omitted only to secure brevity. This feature is illustrated by the first paragraph in the book which defines *physics* in a manner which is elegant but so general as to leave doubt in the reader's mind as to whether physics and physical science are one and the same.

At the outset the author enunciates his conviction that "certain concepts used in physics are deductions and generalizations from individual experience and can not be strictly defined. Such are the concepts of *extension* (space, with its subdivisions of volume, area, length and direction), *time, force, warmth, cold,* etc." On the same page, a *physical quantity* is defined as "a definite concept capable of measurement."

Every one who thus finds *force* listed among the indefinables will surely understand that Professor Guthe here means to imply nothing more than that no complete and satisfactory definition has yet been given. For only a few

pages later we find that he himself offers the following definition:

"*Force* is the cause of a change or of a tendency to change in the state of rest of a body or of its deviation from uniform rectilinear motion. The idea of force is based upon the fundamental concept of the effort necessary to change the position of a body at rest or the uniform rectilinear motion of a body. It is assumed to be the cause of such a change, to be proportional to the acceleration produced, and to be in the direction of the added acceleration. It is a vector quantity. A force is measured by the equation $F = ma$, which may serve as a definition."

Waiving all considerations which might be urged against this definition on the ground that physics is not at all concerned with "causes," and laying aside all pedagogical considerations, your reviewer would like to ask, purely for information, this one question: Is there any single property, save only the space-variation of energy, which is characteristic of all the physical quantities which one finds labelled as "forces" by the leading physicists of the present time? Is there any single feature, or set of features, which can serve as a defining quality for force? No question is here raised about any general definition of force such as that which occupies ten columns of fine print in the great Oxford Dictionary. *The inquiry here made is much simpler. It pertains only to the forces which are employed every day in physics.* The one and serious objection against defining force in terms of energy or work is, of course, the fact that work and energy are universally defined in terms of force.

The crux of the situation would then appear to be the following: one is compelled either to employ the vicious circle just indicated or to discover some property other than space-variation of energy, which is common to all forces. It goes without saying, perhaps, that the space-variation here referred to is that employed by Lagrange in his definition of generalized force,[1] and is intended to include both angular and linear space. To make it perfectly clear that there is nothing hazy or indefinite about the query here raised it may be well to summarize the principal types of force which one meets in any standard discussion, such as that of Thomson and Tait, or Webster.

[1] *Mec. Anal.*, I., p. 334.

1. First of all there is the straightaway mass-acceleration in which the momentum of a particle is altered while its direction of motion remains constant, *e. g.*, a particle falling under gravity.

2. The force which produces a change in the direction of momentum of a particle, leaving the scalar value of its momentum constant, *e. g.*, contrifugal force, $mv\omega$.

3. The non-conservative force which is independent of the speed and is illustrated, within limits, by that of sliding friction. One may of course assign a part of the force of friction to the mass-acceleration of the small abraded particles.

4. The non-conservative force which varies directly as the speed, and possesses a dissipation function, illustrated by certain viscous resistances. Here again one may assign acceleration, hence speed and heat, to the small invisible particles.

5. The force which produces a change in the shape or size of an elastic body or in the configuration of a gravitational, magnetic or electric system.

The reader will find a more elegant analysis of the typical mechanical forces in Webster's "Dynamics," p. 123; but the above list suffices to show the diversity in which some common factor is sought. If we admit that a mass-acceleration is characteristic of the first four types listed above, can the all-powerful electron theory bring the fifth type also into this category? Or is there some better way around this *impasse*? Or must we concur with Professor Guthe in his opinion that force can not be defined? To say that it is sometimes definable and sometimes not is about as satisfactory as that ancient testimonial of good character which asserted that "the man is honest; at least he is honest nine times out of ten." Even those who believe there is something profound and mysterious about the concept of force, just as there is something

away beyond our ken in the structure of matter, say of copper, will confess that the chemist can point to a certain set of properties which are necessary and sufficient to delimit copper from every other known substance. The question here raised is similar, namely, Can forces be grouped into a class by themselves? And, if so, what are the marks, or the one mark, by which this class is set off from the other physical quantities? Dr. Dadourian, in his "Analytical Mechanics," p. 15, has perhaps given an answer to this question: but if so, only by introducing a term—*action*—which the intelligent reader will consider an undefined synonym of *force*, equally complex and equally indefinite.[2] Every one agrees that a force is represented, in a general way, by a *push* or *pull;* but the question here raised is this: How is a *push* to be defined in a quantitative and consistent manner?

Returning now from this digression suggested by Professor Guthe's treatment of mechanics, the definitions in *Sound* and *Heat* are brief and excellent. Those in Magnetism and Electricity are introduced with the interesting remark that "the existence of ether in space is accepted as a means of interpreting phenomena that can not be explained by the properties of ordinary matter." The definitions which follow are especially fine and are certain to furnish new and helpful viewpoints to any serious student; the same is true of the section devoted to optics. Where differences of opinion might arise—and they are numerous—one feels always that the text, as it stands, clearly sets forth the essential facts of the case.

HENRY CREW

Introduction to the Study of Igneous Rocks. By GEORGE I. FINLAY, Ph.D. New York and London. McGraw-Hill Book Company, Inc. 1913. Pp. vii + 228. Price $2.00 net.

This little book is said by its author to be intended as an introduction to the exhaustive treatises on the subject of igneous rocks, and consists of a brief statement of the qualitative classification of igneous rocks; a description of the method of determining such rocks in hand specimens, and a short chapter on the optical properties of minerals and the methods by which they are determined. This is followed by chapters on identification of the essential and accessory minerals of igneous rocks; and by chapters on the "igneous type rocks" and of varietal rocks related to the type rocks; a brief synopsis of a method of describing rocks; and an outline of the quantitative classification of igneous rocks, with numerous examples of the method of calculation of the norm, with numerical tables to facilitate the calculation. There are also tabulated statements of the physical characteristics of the chief rock minerals.

The book is well gotten up and is to be commended for its author's appreciation of the value of quantitative methods of determination and description, and for his simple and direct manner of describing the ordinary method of procedure in the customary identification of rocks in hand specimens, and of minerals under the microscope.

It is a mistake, however, to call the book an introduction to the more serious study of igneous rocks as set forth in larger treatises on the subject. It would seem to have been prepared for a class of students who did not intend to study the subject thoroughly, a very large and legitimate class who desire only a slight knowledge of the subject. For the work labors under the disadvantage of an attempt to simplify a highly complex subject, and to express in a few words ideas and definitions which require fuller statements and amplification in order to be correct. The attempt has led the author into some errors that he might have avoided. It has emphasized the idea of rock types, which will lead students to expect what they will not find in nature, and it has given false ideas as to the composition of rocks having the commonest names. The author himself remarks that the concise statement made in the table of igneous rocks on page 98 may readily be misinterpreted by the beginner. Why then make it? It certainly conveys the impression that andesites are characterized by mica and amphibole, and that

[2] See Rettger, SCIENCE, January 23, 1914, p. 140.

pyroxene is subordinate. One who is not a beginner knows that most andesites contain more pyroxene than mica or amphibole; and in many instances pyroxene without either mica or amphibole. The impression is also given that granite does not contain lime-soda-feldspar. There are numerous inaccuracies of statement and definition that might be pointed out, which may be charged to the attempt at simplification. It does not seem desirable that students who intend studying petrology thoroughly should begin by studying it in an inadequate manner, and experience the necessity of remodeling some of their fundamental concepts.

Joseph P. Iddings

An Introduction to the History of Medicine, with Medical Chronology, Bibliographic Data and Test Questions. By Fielding H. Garrison, A.B., M.D. Philadelphia, W. B. Saunders Co. 1913.

The reproach that has been brought against modern science to the effect that it looks only to the present and future and gives little consideration to the past, probably finds the least amount of justification in the case of the medical sciences, if one may judge from the rapid increase within recent years in the amount of literature, both periodical and monographic, that deals with the history of these sciences. But it has been to France, and more especially to Germany, that we have been principally indebted for compendious treatises on the history of medicine, the only works of that nature written within recent years by English-speaking authors being the brief "Epitome" of Dr. Roswell Park and the delightful "History of Physiology" by Sir Michael Foster. The publication of the work before us is, therefore, an event of no little interest, since it places in the hands of English readers a reliable, comprehensive and interesting account of the development of medical theory and practise, from the earliest times down even to the present day. It is noteworthy also in that its production has been made possible by the unequalled collection of works dealing with the history of medicine that has been brought together in the library of the surgeon-general at Washington. Dr. Garrison is to be heartily congratulated upon the excellent use he has made of it.

The book opens with an introductory chapter on the identity of all forms of ancient and primitive medicine, and then follow chapters on Egyptian, Sumerian and Oriental, Greek (under which are included the Alexandrian and Roman schools), Byzantine, Mohammedan and Jewish, and medieval medicine, all these being treated in the brief space of one hundred and thirty pages. Then follows a well-balanced chapter on the period of the Renaissance, but the greater part of the book, nearly five hundred pages out of six hundred and sixty odd, is devoted to the history of the sixteenth to the twentieth centuries, the chapter on the twentieth century giving a welcome review of the development of our knowledge of such subjects as the internal secretions, the synthesis of proteins, parasitology, chemo- and sero-therapy.

Each chapter consists of a biographic and a general portion, the former setting forth the main features of the lives, endeavors and accomplishments of those who have contributed in any degree to the advancement of medicine, while the latter sums up succinctly and clearly the conditions under which they lived and worked. As appendices there are added a useful medical chronology, a bibliography and a number of test questions, many of which suggest interesting topics for further study and investigation. Finally, mention should be made of the excellent indexes, one of persons and another of subjects, both of which appear to be entirely satisfactory.

Dr. Garrison's book forms a trustworthy reference for those who are interested in any phase of the development of medicine. No name worthy of mention, unless it be that of Dodoens, seems to have been omitted, and although the treatment is fundamentally biographic, the subject index makes it easy to ascertain the essential events in the development of special departments of medicine. And yet with all this thoroughness in so small

a compass, the book is far from being a mere catalogue of names, facts and dates. The author's style gives life to his descriptions; he has the happy faculty of seizing upon the salient points of his subject and vivifying them by allusion, comparison and quotation. Interest, too, in the text is greatly increased by the large number of portraits with which it is illustrated, a feature that especially distinguishes the book in comparison with its predecessors.

In covering so vast a field errors are almost unavoidable; nevertheless the number to be noted in Dr. Garrison's book is so small that it seems almost invidious even to mention them. It hardly seems just, however, to speak (p. 78) of Galen as "little of an anatomist." Surely the writing of such a treatise as the "De Anatomicis administrationibus" in the second century marks its maker as one of the greatest of anatomists! The title of Averroes' great work (p. 89) is not "Ketab," but rather "El-Kollijat," of which the word "Colliget" is merely a transliteration. Mention should surely have been made (p. 149) of the splendid "Quaderni d'Anatomia" of Leonardo, at present being edited by Dr. Hopstock and his colleagues. The discovery of the pancreatic duct by Wirsung (p. 180) was made in the dissecting room of Vesling and not in that of Vesalius. The statement (p. 602) that "twins always have the same sex" is manifestly in need of correction. There are also a few obvious minor slips, and one must regret the omission from the bibliographic appendix of such works as the excellent Vorlesungen of Professor Ernst Schwalbe, Le Clerc's "Histoire de la Medicine Arabe," Lauth's "Histoire de l'Anatomie" and Medici's interesting "Compendio storico della Scuola Anatomica di Bologna."

But such errors and omissions are of little account beside the general excellence of the work. Its thoroughness, conciseness and clearness bespeak for it the fullest appreciation from all who are interested in the past and future of medicine.

J. P. McM.

Stammering and Cognate Defects of Speech. By C. S. BLUEMEL. 2 vols. New York, Stechert and Company. 1913.

The first volume is called "The Psychology of Stammering" and the second reviews critically many of the current systems for the treatment of speech defects. The first hundred pages of Volume I. are employed in a popular exposition of such psychological facts and opinions as the author may later need in his description of the etiology of stammering. The chapter headed "The Brain" deals rather dogmatically with some of the mooted questions of cortical localization and lacks many references to original sources. The chapter on aphasia is well handled and serves as an excellent introduction to the author's thesis that "the stammerer's difficulty is transient auditory amnesia" (p. 187). It is well shown that this amnesia attaches to the vowel sounds, especially to the more obscure ones, and that it is characteristic of the audito-moteur rather than of the subject possessing predominantly the visual type of imagery. We have already (pp. 98 and 103) been prepared for this position by the foregoing discussion concerning the necessary incitation for voluntary speech. This, it is held, always involves kinesthetic imagery, auditory imagery being supplementary and functioning chiefly in vowel production. Consonant production may be actuated by kinesthetic imagery alone, but not so the formation of the short and relatively "colorless" voice sounds. When the auditory imagery is temporarily lost or weakened the more obscure vowel sounds become impossible of production and stammering results. This position is strengthened both by introspection and by the records of speech cases, and if correct is of the utmost value in indicating the appropriate treatment for stammering.

Volume II. includes an excellent account of current systems of training, treated under the chapter titles: Respiration, Vocalization, Articulation, Verbal Exercises, Mechanical Appliances and Psychological Methods.

STEVENSON SMITH

SPECIAL ARTICLES

TILTED SHORELINES OF ANCIENT CRAIGTON LAKE, OHIO [1]

Description.—A lake bed mentioned by Read,[2] by the present author[3] and by Dachnowski[4] lies in a mature, branched, preglacial, north and south, valley west of Wooster and east of Ashland, Ohio. The lake which occupied this bed shortly after the ice withdrew is called Craigton Lake. It may be said to center near Funk, Ashland county, and to extend in three arms, southward seven miles, northward about eleven miles and northwestward twelve miles. The main north-south axis is a little more than eighteen miles long.

That such a lake[5] really existed is abundantly attested by beaches, cliffs, deltas, water-modified moraines and extensive flats of lake clays.

A cursory examination of the features in 1912 suggested that the beaches were not now horizontal and during the past summer careful instrumental leveling starting from U. S. Geological Survey bench marks has been done at several points along the lake plain. By this means it was found that the beach lines are far from horizontal.

The delta surfaces at the northern end are 1,040 feet above sea level. Some little wave work can be seen higher. Three miles and a half southward the beaches are at about 1,020. The altitude of 1,000–998 was found about a mile north of Funk. At Craigton the beach is 973 feet high and at the southern end we found it to be 960 feet with no wave work higher. Allowing 5 feet for possible fans or outwash deposits on the delta at the upper end, where the proper level on which to read is extremely difficult to determine, we still have 1,035 here and a difference of 75 feet in 18 miles, the southern end being lower by this amount. This means a tilting upward relatively at the north with reference to the south end of about 4 feet in a mile.

Interpretations and Correlations.—The postglacial tilting of the shorelines of the precursors of our Great Lakes has long been recognized. Very little evidence has been found of tilting south of the borders of our present lakes. The long east-and-west abandoned beaches across Ohio show almost no tilting, but lines running more nearly north and south are appreciably displaced. The evidence presented above carries actual tilting 50 miles south of the most southern part of Lake Erie, itself the most southern lake. Furthermore the rate of tilting is greater in this case than that observed on many of the abandoned beaches further north.

Goldthwait[6] who has worked extensively on abandoned beaches to establish the amount and kind of warping that may have taken place, shows that the Algonquin beach is not tilted south of a line through the middle of Lake Michigan and Niagara Falls. In the same paper he shows that the older Iroquois beaches are tilted more than the Algonquin in the same latitudes and that the tilting extends farther southward for the Iroquois beach. He shows that the tilting is greatest further north and decreases southward, but he is unable to locate any southern limit for the tilting.

That the existence of Craigton Lake began earlier than that of any of those preceding even Lake Erie is easy to believe because of its location with reference to the retreating ice. Its site would be uncovered even before that of Lake Maumee. That tilting in the lake region began early is also shown by the fact that Craigton Lake shorelines are tilted more than such beaches as those of the Algonquin and Iroquois water planes. The warping in Craigton Lake lines amounts to four feet in a mile and is quite uniform for the 18 miles of length. It may be a little steeper in the last two or three miles at the north end

1 Summary of a paper presented before the Ohio Academy of Science, at Oberlin, O., November 29, 1913, and published by permission of the state geologist.

2 M. C. Read, Geol. Surv. Ohio, 1878, Vol. III., pp. 519–529.

3 Geo. D. Hubbard, *Am. Jour. Sci.*, 1908, Ser. 4, Vol. XXV., pp. 239–43.

4 A. Dachnowski, Geol. Surv. Ohio, 1912, Ser. 4, Bull. 16, p. 134.

5 Full description of this evidence with maps and section will appear in *Amer. Jour. Sci.* soon.

6 J. W. Goldthwait, G. S. A. Bull., Vol. 21 (1910), pp. 227–248.

but probably is not. The apparent increase in rate is more likely due to aggradation with glacial outwash or to the building of a fan on the delta at the northern end.

Craigton not only began, but probably completed its history as a lake before the tilting occurred; a considerable part of its tilting must have occurred before the Iroquois beaches were tilted and all of it before the Algonquin was tilted, because in the first place its tilting is greater than that of the Iroquois; and in the second, Algonquin tilting did not proceed so far south. Had water remained in Craigton during the tilting, it must have spilled over southward. There can be found no evidence of static water work on the hills above the recorded beach levels at the southern end. If water stood higher here, then many tracts, low between moraine hills but higher than 960 feet, should have been under water and should attest that fact by sorted drift, lake clays, and possibly by black earth deposits of palustrial origin. Nothing of the sort can be found.

Because the outlet was in the middle portion of the lake the southern part would not be drained by the tilting. Drainage possibly fairly well established would be interfered with; swampy conditions would develop and will persist until more perfect drainage is attained. Black, peaty earth, very abundant in the southern part, confirms the belief that this end of the lake was long swampy. In fact artificial ditching has but recently put it into agricultural condition. Hundreds of acres of onions are now grown on the black flats that are sufficiently drained. Water does not stand anywhere on the plain but swampy conditions are not entirely removed.

George D. Hubbard

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Oberlin, Ohio

THE AMERICAN SOCIETY OF ZOOLOGISTS

II

COMPARATIVE PHYSIOLOGY

The Reactions of Normal and Eyeless Amphibian Larvæ to Light: Henry Laurens.

Although the photic reactions of Amphibians have been extensively investigated very little has been done on the larval forms. The purpose of the present investigation was to test the reactions to white light of normal and eyeless frog (*R. pipiens* and *R. sylvatica*) and *Amblystoma* (*A. punctatum*) larvæ. The optic vesicles were removed from the blinded individuals at a stage of development soon after the closure of the neural folds, when the tail bud is just beginning to be perceptible. Frog larvæ, both normal and blinded, show no reaction to the stimulus of light. Both normal and eyeless *Amblystoma* larvæ, however, show a very decided positive phototaxis. The reactions of the blinded individuals are apparently not due to the direct stimulation of the central nervous system by the light as is shown by a series of experiments in which three small areas of the larvæ were illuminated, these areas being roughly the head-region, the ventro-lateral mid-body region, and the tail-region. Positive responses were obtained when each of these regions were illuminated by a narrow beam of light, the percentage of positive responses being practically the same in each case. The skin chromatophores of *Amblystoma* larvæ show different conditions of expansion and contraction of their pigment under different conditions of light and darkness; the conditions in the normal and blinded larvæ being exactly opposite. Normal larvæ placed in diffuse light are pale (light brown), blinded larvæ so placed are very dark. Normal larvæ placed in darkness are darkly pigmented (dark brown), while blinded larvæ so placed are very pale. But normal larvæ placed in diffuse light on a black background are darkly pigmented, thereby showing the effect of the background. These different conditions of the pigment in the skin chromatophores do not affect the sensitiveness of the larvæ to light, but previous exposure to light or adaptation to darkness do, in that dark-adapted larvæ are more sensitive to light than are those which have been kept in the light.

An Analysis of the Egg Extractives of Arbacia and Asterias: Otto C. Glaser.

Analyses (1) by means of sperm-suspensions; (2) by means of qualitative chemical tests; (3) by means of the rate of development, were made. The results briefly summarized, are:

1. A general corroboration of F. R. Lillie's observations with respect to *Arbacia punctulata;* their extension in certain directions, and their application to *Asterias forbesii.* Hetero-agglutination and hetero-activation between *Asterias* and *Arbacia* were found. Agglutination is very likely the result of a surface effect.

2. Proteins, if present at all, do not necessarily come from the eggs, and are extremely dilute. Reducing substances seem to be absent. The agglutinin is heat-resistant. A purple compound, apparently specific for *Arbacia*, is formed when the sperm, the eggs or the agglutinin itself undergo certain changes. More soluble substances are secreted at the moment of fertilization than before. This, together with the fact that the volume of the eggs is smaller after fertilization, constitutes new and strong evidence in favor of the contention that fertilization involves an increase in permeability. From this it need not follow that fertilized eggs are more permeable than unfertilized. In fact this is not very probable.

3. Egg-secretion as well as egg-extract, in certain concentrations, retards development. NaOH in certain concentrations does not accelerate cleavage, but may even depress it. In the same concentrations, it accelerates the development from the blastula to the pluteus. Egg-secretion + NaOH in the above concentrations retards the cleavages much more than either used separately. One can draw no inference from these experiments as to how the egg-secretion acts in retarding development.

The suggestion that development is initiated as the result of a disturbance in equilibrium in which substances antagonistic to oxidation are eliminated is possible. It is equally possible that the removal of the substances lost allows other equally important processes to be set up. The initiation of development is identical with the initiation of cell division. For this process fertilization, even if it involves all that Lillie's theory includes, can not be considered essential, since somatic cells divide without it. This does not imply that the mechanism of fertilization may not be exactly as F. R. Lillie supposes, but the possibility that the initiation of cell division depends on other processes which also occur at the moment of fertilization remains. Neither these suggestions nor the facts on which they are based appear to the author out of harmony with existing theories. A full discussion will be published in a forthcoming issue of the *Biological Bulletin*.

Feeding Habits of Amœba: Asa A. Schaeffer.

The method of investigation is very simple. A very small particle of the substance to be tested was placed in the amœba's path by a very finely drawn out glass needle. Camera lucida drawings were then made at frequent intervals in order to record the behavior accurately. A large number of substances were used: small animals and plants, isolated proteins, carbohydrates, fats, carbon, glass, carmine, etc.; also capillary tubes filled with solutions of various substances.

It was found that the amœba exercises a considerable degree of precision in selection while feeding; objects of food value being eaten while those valueless as food were rejected. However, of the substances eaten, carmine, india ink and uric acid are probably valueless as food; and of the substances refused, casein, gelatin, lecithin and zein are food substances. What the basis is upon which amœba selects its food can not be stated. But amœba eats everything that moves. If a particle of carbon or of glass or other substance is properly agitated by means of a glass needle, such particle will be eaten.

Amœbas react to objects at a distance, whether soluble or insoluble. The maximum distance through which an amœba may sense an insoluble object 20 microns in diameter is from 40 to 60 microns.

Some amœba may be *led* about by "tickling" with an extremely fine glass needle. A typical "food cup" may also be produced in this way.

The behavior of amœba while feeding is subject to very great variation.

Changes in Pattern and Color in Fishes, With Special Reference to Flounders: S. O. Mast.

Abstract in Science, Vol. XXXVIII., page 699.

The Reactions of the Orb-weaving Spider, Aranea Cavatica; to Rhythmic Vibrations of the Web: W. M. Barrows. (Illustrated with lantern slides.)

It was found by using vibrating tuning forks and an electric vibrator that when one part of the spider's web is set in rhythmic motion (24–100 vibrations per second amplitude 3–12 mm.) the spider orients, advances rapidly toward the vibrating point, and attacks the vibrating instrument, even biting and throwing web on it. This positive reaction was not obtained when irregular vibrations were used as the stimulus. When a double or Y-shaped vibrator was used the spider oriented and advanced directly between the two vibrating points. The author considers this response a typical tropism and suggests the name "tonotaxis" to designate it.

Secretion in the Protozoan, Folliculina: E. A. Andrews.

This specialized *Stentor* secretes a transparent case of green or brown color, resembling a stocking in form. The rounded foot has one flat side

firmly fastened to some solid, the long leg rises up 45 to 90 degrees from the sole and bears on its outside a spiral ridge of six or more turns, while its mouth is completed by a reflexed lip. Three factors enter into the making of this case: the co-ordinated contractions of the body; the behavior of the cilia; a special secretion. The first factor determines the form of the case, which is then a permanent record of the secretory "instincts" of the animal. The animal first assumes the shape of the future foot of the case and secretes this about itself. Then by a special set of contractions of the anterior part it forms a mould upon which the spiral tube is made, turn by turn, with the measured elongation of the rest of the body. Finally, by an entirely unexpected change in form of the mould the lip of the mouth is added. The only part of the animal in contact with the case is the point of permanent attachment to the bottom of the case, elsewhere the secretion is laid down as a hardening mass separated from the body by the length of the cilia. As the secreting progresses from the foot up the cilia pass through successive states, at first rigid and quiet, then specially active in limiting the inner face of the case wall.

In the posterior end is a special organ, some 10 by 20 microns in diameter, associated with the myonemes.

In response to contact with solids of some kinds the posterior end puts out an adhesive secretion that, apparently mechanically, influences other *Folliculinas*, so that from the free-swimming state they commonly settle down in colonies, each with its separate case, but all fast to a common pellicle spread over the solid object or even over the surface film of quiet water.

The case is secreted when the specialized frontal field and lobes are not yet present.

The Reactions to Light and Darkness of the Melanophores of Frog Tadpoles: DAVENPORT HOOKER.

The tadpoles of *Rana pipiens* were used as subjects for investigation and some seventy-five series of experiments were performed. Each series extended over a number of days and each tadpole was subjected to a variety of conditions. The light used in the experiments was either direct sunlight or the light of a 75-candle-power Welsbach mantle. To obtain total darkness, the tadpoles were placed in blackened light-tight boxes or in an unilluminated dark room.

The following results were obtained:

1. The melanophores in the subepidermal layer of connective tissue of tadpoles respond to light and darkness in the opposite manner from those in the corium of adult frogs, with which they are identical. The former expand in response to light and contract in response to dark.

2. The epidermal melanophores do not respond.

3. The color of the background has no effect on the nature of the response in tadpoles.

4. The transition from the larval to the adult type of response takes place after metamorphosis.

5. Continued exposure to darkness produces a secondary reaction of expansion of the melanophores in the tadpole. This follows the primary reaction of contraction by an average of six hours.

6. To again obtain contraction of such expanded melanophores, the tadpole must be exposed to light.

The Movements of the Dog-fish as Determined by Olfactory Stimulation: G. H. PARKER.

A normal dog-fish, when confined in a large pool, swims more or less continuously back and forth, turning at the ends of its course. When excited by food, it courses over the bottom of the pool, turning now to the right, now to the left. This form of locomotion does not occur when the nostrils are occluded with cotton. Hence the food excitation is an olfactory response (Sheldon). When excited by food, a normal fish turns about as often to the left as to the right and generally exhibits a course like a figure eight. When only the left nostril is occluded, the fish turns predominately to the right; when the right nostril is plugged, predominately to the left. In each case the predominating turns may be as many as 90 per cent. of the total turns. These observations lead to the conclusion that, in seeking food, the dog-fish commonly turns toward the more vigorously stimulated nasal organ.

The Oxygen Utilisation of Fishes: G. G. SCOTT.

Internal Pressure in Sponges: G. H. PARKER.

The internal pressure under which the current of water flows through a sponge was measured hydrostatically and found to vary in eight species of marine sponges from one to four millimeters of water. In *Spinosella sororia* an average finger discharges under a pressure of about three millimeters of water 78 liters of water a day. A colony of twenty such fingers would discharge about 1,575 liters a day, or over 415 gallons. Sponges move large volumes of water at very low pressure.

A Study of the So-called Life Cycle in Oxytricha fallax and Pleurotricha lanceolata: GEORGE A. BAITSELL.

Further Light on the Conjugation of Paramœcium: L. L. Woodruff.

This paper will appear in the *Jour. Exper. Zoology*, February, 1914.

Reactions of Amœba to Light: Asa A. Schaeffer.

Perpendicular beams of white and of monochromatic spectral light about 20 microns in diameter were projected through the microscope after being passed through 20 centimeters of water. The beams were projected in or near the paths of amœbas.

The amœbas reacted to these beams of light before they came into contact with them as seen by the human eye. In nearly all cases the reaction was positive, that is, the amœba moved toward the beam of light. There was very little, if any, difference observed in the reactions toward beams of white and of the various spectral monochromatic lights.

Brightly illuminated food particles were eaten neither more nor less readily than when illuminated evenly with the field; but when very slightly illuminated, that is, when laid on a "dark spot," the food object was sometimes not eaten.

Amœbas frequently move toward a beam of light in a curved path, finally coming into contact with it; occasionally the curved path extends around the beam of light so that the amœba encircles the beam for a greater or less distance without coming into contact with it. If an amœba has oriented itself with respect to a beam of light, the beam may then be extinguished without causing a change in the direction of movement. Such continuance of the direction of movement after an orienting stimulus is removed is due to "functional inertia," by virtue of which in this case the amœba tends to keep on moving in a certain direction after it is once started. No external stimuli are necessary for continuing in a straight path. The encircling of objects and of beams of light seems to be due to a balance between a tendency to keep on moving in the original direction (functional inertia) and a tendency to react positively to the stimulating object.

The Olfactory Sense of the Honey Bee: Norman Eugene McIndoo. (Introduced by E. F. Phillips.)

The Feeding Habits of Amblystoma Larvæ: H. S. Burr. (Introduced by R. G. Harrison.)

Normal *Amblystoma* larvæ use the visual sense in obtaining food when it is abundant. When the food becomes scarce the larvæ move slowly about in search of it, nosing in the débris at the bottom of the aquarium. This characteristic reaction suggests the use of the olfactory sense.

Experimental evidence was sought to determine how great was the reliance on this sense. Normal larvæ were tested with bits of motionless beef, sand and live but motionless Daphnids. These tests resulted positively—that is they snapped at the source of the stimulus—in 91.6 per cent. of the Daphnid tests and 38.7 per cent. of the sand tests. The reactions to the beef were comparable to those of the Daphnids.

From eight 5–6 mm. larvæ the nasal placodes were removed under a binocular microscope with the aid of a pair of iridectomy scissors. When they had begun to feed, they were tested by the same methods as were the normal larvæ. No reactions to beef or motionless Daphnids were obtained. To sand they reacted positively in 60.7 per cent. of the tests.

From eight 4–5 mm. larvæ the optic vesicles were removed. These were loaned to the writer by Dr. Henry Laurens. These were tested with motionless Daphnids. They reacted positively in 98.8 per cent. of the tests.

In the sand tests, the normal larvæ as they grew older showed an adaptation, in that the percentage of positive reactions was greatly reduced in the tests of the older individuals. The noseless individuals showed no such adaptation.

Hence we may conclude that the larval *Amblystoma*, while using the visual sense in obtaining food when it is abundant, may in the absence of moving food make use of the sense of smell, and that this sense is of increasing importance to the animal as it grows older.

Experimental Analysis of Certain Processes in the Food Vacuole of Bursaria: E. J. Lund. (Introduced by H. S. Jennings.)

ECOLOGY

The Life History of the Bullfrog (Rana Catesbeiana): Albert H. Wright. (Illustrated with lantern slides.)

Because of its size, appetite, vocal accomplishment and shyness, this species has received more attention than any other American member of the genus *Rana*. It frequents marshy bayous, buttonbush swamps, mill ponds, reservoirs, glacial or sphagnaceous lakes and some marshy streams. In first appearance this species is most influenced by water temperatures. When the air reaches 68–75 (certainly 76–79), we may expect the appearance of the bullfrog, provided the water bottoms are

57–64 or average 64–69. The average date of appearance is May 20, the earliest date May 11. At the mating season the first finger of the male becomes enlarged. The type of amplexation is axillary. The breeding season extends from June 15–August 1, the average date of beginning of ovulation being June 30. The female keeps in one position more or less and lays a pancakelike film of eggs on the surface of the water. This film may be from one foot to three feet in diameter. The eggs are laid among brush, driftwood, old stumps in water, etc. During ovulation the prevailing air temperatures are from 71–80; the water maxima from 66–71. It takes only a few minutes to lay the 12,000–20,000 eggs. The jelly is loose, the animal pole black, the vegetative pole white. There is no evident middle envelope. The eggs usually hatch in 5–3 days because usually subjected to a temperature of 65–80. The tadpoles require two or more years of growth before transformation. The relative smallness of the eggs (vitelli 1.2–1.7 mm. in diameter), the late deposition of the eggs, and the greater transformation size required (53 mm. instead of the 9.6 mm. of two or more winters in the larval stage. Besides the toad)—all combine to make this form spend other characters, the best external character is the tail with regular round black spots, some of which are dumb-bell-like in shape. The belly is straw- or maize-yellow, not iridescent. Transformation comes from July 18 to August 15 or months later.

An Experimental Study of the Behavior Agreement of the Animals of an Aquatic Community: V. E. SHELFORD.

The Relation Between Rhcotaxis and Resistance to Potassium Cyanide in Isopoda: W. C. ALLEE.

The cyanide-resistance method which Professor Child worked out as a measure for the metabolic rate of planarians also holds for isopods. This is demonstrated by the effects of changes in temperature and mechanical stimulation upon the survival time in potassium cyanide; also by tests with young and old isopods, and by comparing the survival time and carbodioxide output in the same individuals. Average results from experiments on 452 isopods show that animals giving a highly positive rheotactic response have the highest rate of metabolism. Those giving a highly negative reaction are next, while isopods giving a low positive and high negative or indefinite response have a still lower metabolic rate. Isopods with a high efficiency of movement in the current have a higher rate of metabolism than those with low efficiency. These results support previous work on this subject.

MISCELLANEOUS SUBJECTS

The Reaction of the Honey Bee to Changes in External Temperature: E. F. PHILLIPS AND GEORGE S. DEMUTH.

The Organs of Special Sense of Prorhyncus: WILLIAM H. KEPNER AND WILLIAM H. TALIAFERRO.

The organs of special sense of this rhabdocele are the eyes and the ciliated pits. The two eyes lie beneath the epidermis, within the mesenchyme in depressions at the dorsal surface of the ganglia. The two ciliated pits open on the ventral side of the body anterior to the anterior limits of the surfaces of the ganglia and midway between the lateral surfaces of these cell masses and the margin of the body.

One of the unique features of these four organs is that they are formed of a definite number of cells. There are only eighteen cells involved in the formation of the four organs of special sense of *Prorhyncus.*

Each eye consists of two cells—an accessory or pigmented cell and a retinular or visual cell. The pigmented cell appears to be a modified mesenchymal cell. Its mesial cytoplasm resembles that of the typical mesenchymal cell. The lateral part of its cytoplasm, however, has assumed a definite, cup-like contour. This part of the cytoplasm, in its fixed condition, presents concentric lamellæ with which the pigment of the cell is associated. The mouth of this cup is directed laterally.

The retinular cell appears to be a modified nerve-element. Its nucleus has the characteristic spheroidal contour of a nerve-cell. In the cytoplasm, in its fixed condition, there are three regions. The lateral region is a finely granular cone that lies closely applied to the dorsal surface of the ganglion. The lateral end of this cone, we infer, is continued as a nerve-fiber into the ganglion. The basal or mesial fourth of this cytoplasmic region accommodates the nucleus. The middle cytoplasmic region of the retinular cell is the densest region. It is a concavo-convex disc. We are not prepared to say that this lens-shaped region of cytoplasm acts as a lens for converging the rays of light upon the pigment cell and rhabdome. We shall be content to look upon it as the supporting structure of the mesial cytoplasmic region, which is the rhabdome of the visual cell. The rhabdome is a low sugar loaf-shaped body that fills the cup of the pigmented cell.

The ciliated pits are invaginated regions of the

ventral epidermis, which are directed obliquely posteriorly and mesially. In the structure of each pit seven cells are involved. Six of these cells form a sensory syncytial lining or wall of the pit. These six cells are recognized by their nuclei, three of which form a dorso-ventral row in the lateral wall of the pit and three a similar row in the mesial wall. Stout cilia are borne by the general surface of the syncytial wall. This suffices for the prevalent conception of the structure of the ciliated pits of flatworms. But all of the surface of the wall of the pit does not bear cilia. Just over the middle nucleus of each side there is a well-differentiated sensory rod, so that we may look upon the wall of the pit as being formed by four accessory cells and two sensory cells. A special nerve from the ganglion runs to the posterior dorsal part of the sensory cells of each pit. The seventh cell of the pit is a large gland-cell, which crowns the widened base of the pit. The contour of this gland-cell is quite as indefinite as that of the unicellular glands of the general epidermis. Its secretion granules, however, can be differentiated from the secretion granules of the general epithelial glands by the use of Bordeau red. This unicellular gland opens by pores through the wall of the pit at the anterior angle of the fundus.

Therefore, as we have shown in *Microstoma caudatum*, the ciliated pit is not a simple highly ciliated structure, but it is differentiated into a ciliated, sensory region and a glandular region. Thus the inferred affinity between the *Platyhelminthes* and the *Nemertine* is strengthened by the close resemblance between the structure of the ciliated pit of the former to that of the simpler cerebral organs of the latter.

The Experimental Modifications of Tiger Beetle Color Patterns by Variation of Temperature and Moisture During Ontogeny: V. E. SHELFORD.

Some Experiments on Regeneration in Thinodrilus limosus: MARY T. HARMAN.

Both the anterior and posterior regeneration has been considered. At the anterior end of any piece the maximum number of segments regenerated is six plus the prostomium. The first external indication of differentiation is the differentiation of the prostomium followed closely by the first segment. After that the segment adjacent to the old part of the worm is differentiated from the newly regenerated portion and then the segments are differentiated from the base toward the tip in regular order. Although six segments plus the prostomium are the maximum number of segments regenerated, the size of the regenerated portion and the rate of regeneration varies with the level of the cut and is independent of the size of the regenerating piece and the amount of injury.

There is, also, a region of maximum rate of posterior regeneration and this is independent of the size of the regenerating piece and the degree of injury. The amount of posterior regeneration increases rather suddenly from the head to the region of maximum rate of regeneration and then decreases more gradually toward the tail region. Pieces taken from the most posterior part of the worms do not live long and seldom show any regeneration. The direction of differentiation in the posterior regenerated part is from the base outward. However, the anal opening is soon formed. During regeneration a part of the most posterior portion of the regenerated tail remains unsegmented as a sort of segmental plate.

Will an Earthworm Regenerate Anterior Segments When the Enteric Epithelium is Absent From the Cut Surface?: H. W. RAND AND H. R. HUNT.

The Fly, Œstrus Ovis, Parasitic in Man: H. F. PERKINS.

More than a hundred living larvæ were discharged from a lung abscess in pus and mucus by a boy ill for several months. These small larvæ were identified as the early stage of the sheep bot *Œstrus ovis* and this determination has been corroborated by the Bureau of Entomology. Infection was by the mouth, the fly and the larvæ seeming to be attracted by the purulent discharges.

No case seems to have been recorded of an insect parasitic in the lung of man or any other mammal, and *Œ. ovis*, while it has been found in the frontal sinuses and rarely in the eyes and throat walls of man in Algeria, has only once or twice been found in man in America. The species is not uncommon in the region where this boy lives, and he took care of sheep for three years previous to his illness.

The larvæ were probably living in the abscess for at least three months, but none of them developed beyond the third stage, whereas normally they would in the same time have developed into flattened grubs of ten times the bulk, this retarded growth being attributable to the lack of oxygen in the non-functional lung.

The Effect of Alcohol on the Male Germ Cells, Studied by Means of Double Matings: L. J. COLE AND C. L. DAVIS.

Recent work has amply demonstrated that offspring from alcoholized males are commonly defective to greater or less degree, even though the mother has not received treatment and is presumably normal. Stockard's experiments with guinea-pigs have been especially conclusive, and he has furthermore shown that the effects of the treatment may persist to the second generation of offspring.

The present experiments were undertaken to test this matter with rabbits, and to take advantage of the complete control possible in double matings, that is the mating of a single female to two males at the same period, and the consequent production of offspring from both fathers in a single litter. By breeding a male homozygous for color and an albino male both to an albino female it is possible to assign the young to their respective fathers, since the offspring of the colored male will be colored and those of the albino male will be albinos. If one of the males now be alcoholized while the other is normal, and offspring from both result, any differences, such as defects in the offspring, may safely be attributed to the effects of the alcoholizing of the male, since both sets of fetuses have developed in the same uterus at the same time, and consequently there can be no question of different environmental influences.

As a preliminary test 36 double matings were made in which both males were normal. Of these, 12, or 33⅓ per cent., were successful; that is, young were obtained from both fathers. An inspection of the 24 matings in which the two normal males were used, but in which all the resulting offspring were from one father, shows that the individuality of the male is of more importance than the order in which they are mated to the female. Thus one pigmented male (14.1), before he was alcoholized, was used in 23 matings, an albino male being used also in each case, with the following result:

In 15 litters all the young were from 14.1, although he gave first service in only 6 cases, and followed the albino male in 9 cases.

In 8 litters young were produced from both males. 14.1 gave first service in 3 cases, and was second in 5 cases. Of the 62 offspring produced, 14.1 was the father of 38, and the albino male of 24.

So while as a result of the whole 23 matings there were 190 offspring produced, the albino male sired only 24 of them.

These facts appear to establish a strong individual potency for 14.1. On the other hand, after he had been alcoholized (by the inhalation method), *he failed to sire any offspring at all* when used in conjunction with an albino male, although he was bred to the female first in at least 5 of the 7 matings made. But when he alone was bred to normal females, he sired several litters of young that appeared to be normal. There have since, however, appeared certain signs which may be indications of defects among these offspring.

Summary: There appear to be differences in the "potency" of the spermatozoa of different male rabbits. (This may be due to differential "vitality," expressed as greater or less motility, penetrating power or something of the sort.) Treating a male to the fumes of alcohol quickly lowers this "potency." Litters were born to alcoholized males (when used alone), but there are some indications of defects in the offspring.

Some Negative Results Obtained From Experiments With Fowl Tapeworms: JOHN W. SCOTT.

Ransom in 1909 mentions that we do not know the full life-history of any of the tape-worms found in American poultry. The following experiments were made in an attempt to find the intermediate host of two of three forms, *Hymenolepis carioca* and *Davainea tetragona*. A barnyard was located in which most of the fowls were infected with one or both of these parasites. A number of chicks as soon as hatched were placed in a large screened cage and kept there until the end of the experiment. (1) To one lot of these chicks two species (not determined) of *Menopon* were fed, the lice being collected in large numbers from no less than eighteen old and young fowls in the barnyard. The idea was that, since some of the lice are usually found feeding upon the skin and soiled feathers in the anal region, the fowl might easily swallow some of them while preening its feathers. (2) Within easy access, where the fowls spent much time in scratching out "wallows" around a dung heap, were small annelids (*Helodrilus parvus*). A large number of these were fed to a second lot of chicks. (3) House flies, hatched from pupæ in a screened cage, were exposed to ripe proglottids and to feces taken from the intestines of infected fowls; on following days they were fed to a third group of chicks. Not a single tapeworm was found in any of the chicks when killed, nor in the controls. These results are reported since they appear to be conclusively negative.

Hermaphroditism in the Brook Lamprey: PETER OKKELBERG. (Introduced by R. W. Hegner.)

In a study of the reproductive organs of the American brook lamprey, *Entosphenus wilderi*, it was found that a juvenile hermaphroditic condition occurs normally and that there were three kinds of individuals as regards sex, namely, true females, true males and hermaphrodites.

The sex glands of fifty larvæ, ranging from 7½ cm. to 20 cm. were studied and it was found that 46 per cent. were true females, 10 per cent. were true males and 44 per cent. hermaphrodites. In the adult condition males and females occur in practically equal numbers and the conclusion is reached that all the hermaphrodites develop into males. Out of 15 male specimens examined seven were found which contained undeveloped ova,—some a few and others a great number. These ova were similar in structure and size to those found in the larvæ.

The number of ova found in the mixed gland varied greatly. Sometimes only a single ovum was found and in other cases a large number of ova were present.

The hermaphroditic condition in the lamprey seems to be similar to that found in several of the other lower vertebrates such as *Myxine*, some Teleosts, and in some Amphibians.

EXHIBITS

During the meetings the following exhibits were made by members of the society in one of the rooms of the Zoological Laboratory of the University of Pennsylvania.

E. P. PHILLIPS AND GEORGE S. MUTH (Bureau of Entomology)—Instruments (Thermo-electric Outfit) (Special Scale), used in work on Behavior of the Honey Bee.

S. O. MAST (Johns Hopkins University)—Photographs and Autochromes showing changes in color and pattern in flounders.

ROBERT K. NABOURS (Kansas State Agricultural College)—Specimens and charts illustrating "Inheritance in Orthoptera."

M. F. GUYER (University of Wisconsin)—Demonstration of the X-element of Plymouth Rock Fowls.

J. E. ACKERT (Kansas Agricultural College)—Demonstration of the Innervation of the Integument of Chiroptera.

H. D. REED (Cornell University)—Model of the Pectoral and Axillary Glands in Schilbeodes gyrinus.

CASWELL GRAVE,
Secretary

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE tenth annual meeting of the Association of American Geographers was held at Princeton, January 1 and 2, 1914. About thirty-five members were present and the attendance of members and non-members ranged from twenty-five to sixty. Thirty-six titles appeared on the final program and twenty-eight papers were read.

The officers for 1914 are as follows:

President—Albert Perry Brigham.

First Vice-president—Charles R. Dryer.

Second Vice-president—C. F. Marbut.

Secretary—Isaiah Bowman.

Treasurer—Francois E. Matthes.

Councilors—Lawrence Martin, Robert DeC. Ward, Alfred H. Brooks.

Editor—Richard E. Dodge.

The nominating committee for officers for 1915 consists of C. F. Marbut, chairman, R. H. Whitbeck, H. H. Barrows.

One of the most important features of the meeting was the adoption by the Association of the plan of cooperation proposed by the American Geographical Society. The plan provides for (1) a joint research committee of the two organizations to administer a joint research fund, (2) a joint meeting in New York each spring, (3) the publication by the Association in collaboration with the American Geographical Society of the Annals of the Association, (4) an interchange of the publications of the two societies.

The research committee of the Association consists of: Alfred H. Brooks, chairman, Herbert E. Gregory, Robert DeC. Ward.

An increasingly large proportion of the papers read dealt with various phases of human geography. The first meetings of the Association (1904–1906) were naturally marked by a large number of physiographic papers. Then came a period (1907–1910) when physiography and anthropogeography were alternately ahead. In the last three programs anthropogeography has led, owing chiefly to the growing number of students devoted to the life side of the science. Future programs will probably show a still stronger tendency in this direction, judging by the livelier discussions evoked by the more strictly geographic papers.

The joint meeting in New York will be held April 3–4. The next annual meeting will be held at some point west of Pittsburgh.

ISAIAH BOWMAN,
Secretary

SCIENCE

FRIDAY, APRIL 3, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE EVOLUTIONARY CONTROL OF ORGANISMS AND ITS SIGNIFICANCE[1]

I

A COMPARATIVELY brief period has passed since the evidence brought together by Darwin in connection with the results slowly accumulated from other sources has clearly demonstrated that the diversity of organic life in the world occurs through evolution. It is one thing, however, to clearly diagnose a condition and quite another to understand the causes which have brought about the phenomenon so that similar results may be produced advantageously. With the assumption that evolution was merely the survival of those forms which were best adapted to the environment, generation after generation, the explanation of the method as well as its practical application, namely the improvement of organisms in any given direction, was apparently a simple matter. It seemed evident that man had modified and adapted to his welfare various plants and animals by a more or less unconscious and haphazard selection long before history records civilization.[2] Why then could not civilized man carry forward the work and with the knowledge gained since the principles of evolution were recognized, obtain far-reaching results within a brief period of time. All that seemed necessary was to have individuals

[1] Presidential address before the twenty-third annual meeting of the Ohio Academy of Science, Oberlin, O., November 28, 1913.

[2] One need not be a pessimist to assert the actual evidence thus far obtained indicates that the supposed progress made in the improvement of domesticated animals and plants is nothing more than the sorting out of pure lines and thus represents no advancement.

of a particular organism in large numbers, and by continued selection of the variations best meeting the conditions move rapidly forward by a series of increments toward the goal of perfection. What could be more simple? Instead of corn having an acreage yield of fifty bushels, there would with a proper supply of plant food be a production of two hundred, two hundred and fifty or even three hundred bushels. Instead of politicians with no perspective beyond their immediate welfare—a reelection—instead of college presidents and faculties with their numerous shortcomings—according to the students and occasionally the trustees—there would be the ideal individual bred to specification and not necessarily made in Germany.

Unfortunately, variations with a perverseness incomprehensible uniformly refused to accumulate in the manner desired and at times even demonstrated their obstinacy by retrogression. It was plainly evident that there were limits imposed by nature not easily passed, and in connection with which much experimental work must be undertaken before definite progress was made and the facts fully understood.

With a realization of the difficulties involved in an attempt to apply evolution, it will be well to pause for a moment and consider certain fundamental principles before discussing the results of some of the investigations which for a time at least promised much toward the solution of the problem. Thus it may be stated that evolution in its different modifications postulates in general (1) the occurrence of numerous varying individuals, some of which are (2) eliminated by environmental stimuli leaving few or no offspring, while (3) the survivors transmit to their progeny the characters which proved of selective value, with the result that (4) through the continuation of the process the race eventually becomes adapted to surrounding conditions. The first two propositions are merely statements of fact. The real difficulties of the situation are those of ascertaining how variations which are transmitted may be recognized and produced so that the result will be a cumulative one. Until this is done breeders must continue to proceed in the same haphazard manner that they have followed for countless generations.

By selecting the largest and most perfect ears of seed corn from the variations present in the field, conversely eliminating the remainder from reproducing, the corn grower plants with a fatuous trust in providence that a crop somewhat better or at least as good as the preceding crop will be produced. If it is a type comparatively pure the average may be maintained and the hope partially realized, but the chances for retrogression are far greater than for advancement, inasmuch as there is no means for distinguishing a variation which will be transmitted with equal or better results than in the preceding generation, from one that represents a fluctuation due to nurture and which is non-transmissible. Thus the apparently inferior ear of corn will frequently produce a yield far better than obtained from one which is perfection as graded by the methods of the "corn show," and if from the same pure race, the resultant crop will be at least as good. Artificial methods of hybridization, which furnish an immediate advancement in the succeeding generation, result in a gain which is only temporary. The increased stimulus to growth vanishes as a fluctuation.

Thus it is quite evident that there exists a problem in the evolutionary control of organisms even the partial solution of which will mark an extraordinary advancement not only for agriculture, horticulture,

and animal breeding, but also for society in general.

II

The general results of the investigations bearing upon the evolutionary control of organisms may be grouped around the principles of Mendelism, the mutation theory, and pure line breeding.

The rediscovery in 1900 of the fundamental laws governing hybridization so brilliantly established by Mendel in 1865, but unfortunately concealed in the obscure publications of the Natural History Society of Brunn, opened an extraordinary field for experimental work. This has already developed to vast proportions in connection with both the results obtained and the speculations involved, while the end is not in sight.

The investigations of Mendel, now so familiar to all biologists, and which may be mentioned somewhat in detail here because of their bearing on mutation, consisted primarily in the crossing of tall and dwarf peas, with the result that the first filial (F_1) or hybrid generation consisted entirely of tall plants. When, however, seeds from these plants were sown the ratio of tall to dwarf plants became 3 to 1 in the second (F_2) hybrid generation, a result explained by the theory of dominant and recessive characters on the basis that there are certain determiners of unit characters in the germplasm which dominate over others during the development of the somatoplasm or body of the individual in the higher forms of life. More recently the presence and absence theory has been applied in interpreting the results. In a manner similar to the preceding when smooth yellow peas were crossed with wrinkled green peas the first hybrid generation consisted of smooth yellow forms inasmuch as the character smooth and the character yellow were dominant over the character wrinkled and the character green, and the crosses were known as dihybrids, inasmuch as they differed in respect to two characters. In the second hybrid generation the resultant ratio was 15 to 1 pure recessive, *i. e.*, wrinkled green, although the fifteen consisted of smooth yellow, smooth green, and wrinkled yellow in the proportion of 9 : 3 : 3. In the same way trihybrids have the ratio 63 to 1 pure recessive while any polyhybrid differing in "*n*" characters which mendelize in the usual manner will give an expected ratio of $4^n - 1$ to 1 pure recessive, which will become apparent only through the breeding of large numbers of individuals.

While the preceding summary represents the normal results in connection with the segregation of unit characters, studies of the past few years have demonstrated that many interesting relationships may occur between the factors governing the production of characters. For example, it has been found that two or more determiners are often present either of which will produce the given character as Nillson-Ehle demonstrated in hybrids of brown and white chaffed wheat, while on the other hand two or more determiners acting together may be necessary to bring about an effect. Such a condition exists, as Bateson in 1910 showed, in certain white-flowered sweet peas which when crossed produce purple flowers in the first hybrid generation. The results which have led to the theory of coupling and of repulsion, particularly the latter, where the expectancy of a pure recessive may be one among many thousands, go far toward suggesting a possible explanation of many so-called mutations on the basis of ancestral individuals heterozygous for one or more characters.

Do the Mendelian principles assist us, however, in attaining the goal which we are seeking, namely the building up of an ideal

organism which will continue to transmit its characters? The answer must be in the negative so far as the originating of anything new is actually concerned. Recessives may be obtained. Characters may be redistributed. They were present in the forms first utilized, however.

The mutation theory formulated by De Vries in 1901 approximately at the time interest was being awakened by the rediscovery of the hybridization principles of Mendel, needs no extended explanation to those who have been interested in evolution. Based on cultural experiments with *Œnothera lamarckiana*, one of the evening primroses, the appearance of relatively small numbers of forms which were quite distinct from the parental species and which bred true in subsequent generations, led to the inference that evolution had in many cases proceeded by discontinuous variations or mutations.

Long series of breeding experiments followed in connection with other organisms, both plants and animals, with results quite similar to those obtained by De Vries. Investigations were also made (Fischer, MacDougal, Tower, etc.) where organisms were subjected to stimuli abnormal in their nature, with the result that a modified progeny was obtained which bred true to the apparently induced character in succeeding generations. Furthermore, cytological studies (Gates, etc.) demonstrated some interesting relationships so far as differ- "mutants" were concerned.

While the evidence is far too insufficient to allow more than a tentative opinion, there are several conclusions concerning mutation which appear justified. The nature of the results obtained through the various agencies make it quite evident that they are not all due to a single underlying principle. There are many "mutants" the origin of which is most certainly to be explained on the basis of a heterozygous condition of the gametes, and much evidence has accumulated that *O. lamarckiana* of De Vries on which the mutation theory was founded belongs to this class. Furthermore there are mutants developing in connection with the action of abnormal stimuli although it is not at all improbable that some of these result from heterozygotes. It may be mentioned that Humbert (1911) in experiments with 7,500 pure line plants of *Silene noctiflora*, one of the "pinks" utilizing methods similar to those of MacDougal, failed to obtain any "mutants." Another explanation of the results in connection with the influence of abnormal stimuli is that the modification takes place through the destruction of a factor and thus the process is one of subtraction instead of addition. There are also investigations, notably those of Gates, in which the aberrant organism apparently results from the abnormal behavior of the chromosomes at some stage during the life cycle. *Œnothera gigas* with its tetraploid chromosomes is here of much interest.

Notwithstanding these diverse results, there is little indication that anything actually new has been added to the organism which would not have occurred within a pure line. If this is true the heterogeneous school of mutationists can be of little assistance beyond suggesting the way in which evolution did not take place.

The experiments on the basis of pure line breeding belong to a comparatively recent period and are of the utmost importance. Johannsen in 1903 published results based on a pure line of beans self-fertilized for successive generations and evidently homozygous. From a bean weighing 95 centigrams and far above the average in size he obtained plants producing beans varying in weight from approximately 35 to 70 centigrams, but all far below the weight of the parent. Utilizing

these in turn as parental forms, from those having a weight of 35–40 centigrams there resulted a progeny with an average of 57.2 centigrams, while from those having a weight of 65–70 centigrams a progeny was obtained which had an average of 55.5 centigrams. In other words, selection had not only failed to make any advancement, but actually resulted in a slight retrogression. Facts quite in accord with this but giving much more pronounced results have been obtained by Tower (1906), Jennings (1908), Johannsen (1909) and others. It should be noted, however, that there have been several experiments, notably those of De Vries with buttercups, Tower with potato beetles, and Smith with Indian corn, where a possible advance of a character was recorded in a group. Heterozygotes here may have been responsible for the result, although again the explanation may consist in the elimination of the effects of a determiner.

The results in mixed races as exemplified by corn, beans, etc., where selection has gradually improved a group of organisms but finally reached a limit beyond which no progress appeared possible, are comparatively well understood and are due, as explained by Shull (1908), to the separation of the pure lines which were present in the race at the beginning. This is where the average agriculturist, horticulturist, and animal breeder has gone far astray and, having succeeded for a few generations in making progress, has failed to understand why he may not continue to be successful.

Thus we find that attempts to modify a character by selection within pure lines within a small number of generations have almost universally failed, and that the few apparent results to the contrary must be looked upon with the suspicion that the population was a mixed race and that Mendelian principles applied.

Once again we are led to propound with still greater emphasis the question, "How then has evolution taken place?" "In what manner have organisms acquired their characters?" "Is it possible to escape the difficulties that confront the investigator on every side?"

III

The application of statistical methods to problems of biology has provided and will continue to provide facts of decided value obtainable in no other way. Nevertheless, the use of data "en masse" uncoordinated with experimental methods can not solve the riddle of existence so easily as some, at an earlier period at least, would have had us believe. There are, however, investigations which seem fundamental to the problem under discussion and which may well be approached from the statistical side. These relate to the influence of certain factors composing the environment as well as to the part played by asexual and sexual reproduction, corresponding in reality to close and cross breeding, upon variability and size in organisms.

Some studies undertaken in 1900 in connection with the influence of food supply on variability[3] based upon the comparison of groups of *Chrysanthemum leucanthemum* L., the common white daisy, as well as *Perca flavescens* Mitch., the yellow perch, indicated that the difference in variability as evinced by the coefficient of variation for a group with a maximum food supply as compared with a group having a minimum food supply, was extremely small and well within the limits allowed by the probable error. From this the inference was that external stimuli played an extremely unimportant part under normal conditions as a cause producing variability in general.

Attempts were subsequently made to ob-

[3] Science, p. 728, 1907.

tain data bearing on the results of close breeding and cross breeding which differ merely in degree from parthenogenesis and amphimixis. The question is an important one, for if cross breeding is only valuable in sorting out and combining existing characters, it not only obscures the facts, a knowledge of which is necessary before progress can be made in building up new characters, but results in no actual advancement in cumulative evolution. Here the material for study consisted of scalariform or cross-bred and lateral or close-bred (parthenogenetic) zygospores—in reality the young individuals—of the common filamentous green alga *Spirogyra inflata* (Vauch). Upon applying statistical methods the close-bred zygospores were found to be 23 per cent. more variable[4] in size as well as larger, both in length and actual volume, than the cross-bred zygospores. The results were not in accord with the general belief that cross breeding increased variability, although studies by Warren, Kellogg, Casteel and Phillips had pointed out that this belief was not substantiated by facts, which, however, did not actually warrant the idea that variability was decreased in cross-bred forms. The studies on the zygospores also suggested that sex existed primarily for the purpose of limiting variability, a hypothesis proposed on purely theoretical grounds by Hatschek in 1887. Another conclusion which followed from the same investigation was that in connection with the origin of death[5] and which may be mentioned here. This is summarized by stating that death apparently occurs as the result of the continually forming body cells becoming so variable through absence of control by amphimixis, that eventually some one group of functional importance fails to meet the limits imposed by the environment. In consequence of this the group, together with the remainder of the colony—the individual—perishes.

In connection with the difference in the variability of close-bred and cross-bred zygospores it seems quite evident that the result is brought about by some factor other than the environmental stimuli which are assumed to produce fluctuation, inasmuch as the material was homogeneous in every respect with the exception of the manner of reproduction. The question is a difficult one, however, not to be settled by a single investigation giving positive results, and because of its importance should receive attention.

In reference to those who hold to the belief that cross breeding, conjugation and amphimixis—the three terms differ merely in degree—increase variability, it may be well to inquire concerning some of the evidence which has been instrumental in formulating the opinion. Without any desire to be critical and at some risk of exceeding the controversial bounds which a paper of this nature allows, a few of the more important investigations touching upon the subject will be considered.

Castle, Carpenter, Clark, Mast and Barrows (1906) in a series of observations as to the effect of cross breeding and close breeding on the variability and fertility of the small fruit fly, *Drosophila ampelophila* Loew., stated that "inbreeding did not affect the variability in the number of teeth on the sex comb of the male, nor the variability in size," basing the opinion on the coefficient of variation in the number of spines and the standard deviation in the length of the tibia. In the former case the data certainly do not permit a clear conclusion one way or the other, but the value of the character which represents the sum of the teeth of the sex combs of the right

[4] Science, p. 907, 1908.

[5] Science, p. 935, 1912.

and left proximal tarsal segment, where there is undoubtedly correlation, may be open to objection under any consideration. If, however, from the data presented in the study the value of the coefficient of variation is computed, which, strange to say, was not done in the paper, and thus allowance made for the greater length of tibia in the cross-bred forms, the combined inbred forms exhibit a variability relatively 68 per cent. greater than the cross-bred forms.

Jennings (1911) in summarizing breeding experiments with *Paramecium* concluded that "The progeny of conjugants are more variable in size and in certain other respects than the progeny of the equivalent non-conjugants," and farther, "Thus conjugation increases variation." Continuing the investigations, he subsequently stated (1913) that conjugation increased the variation in the rate of reproduction. While the careful methods used by Jennings have brought to light many interesting and valuable facts, it is evident, from a critical consideration of the data, that they by no means allow such conclusions.

So far as size is concerned in a pure race, non-conjugants and their progeny were more variable than conjugants and their progeny, as noted in Table No. 28. In a wild race the progeny of the conjugants were slightly more variable than the progeny of the non-conjugants, as illustrated in Table No. 32, although in two of the nine generations tabulated the variability was greater in the case of the non-conjugants. So far as the rate of fission is concerned, the evidence is unmistakable that the conjugants were more variable. There is, however, a comparatively simple explanation for this when the statement is noted that the number of abnormal individuals, as well as the mortality, was greatest among the progeny of the conjugants. With a considerable number of forms thus having a lower rate of fission, one could expect nothing except a greater variability in the rate of fission. This becomes the more evident when it is found that the higher variability of the conjugants was caused by the considerable number with the low rate of fission.

Considering the data obtained in the breeding of plant forms where the assumption has long been prevalent that hybridization increases variability, it is found that the variability of the F_2 generation as compared with the F_1 generation or a single parental generation may be increased, but that the actual variability as a whole is not increased when the united parental types are taken into account. This may be illustrated by utilizing data from an interesting paper by Hayes (1912) dealing with correlation and inheritance in tobacco. Here, calculating the constants for two parental types combined (401 and 403) in respect to number of leaves and height of plant, it is found that the coefficient of variation has decidedly decreased through the hybridization, although the number of combinations have increased.

There exists the possibility, however, that variability will appear to be increased when forms having the same phenotype but different genotypes are bred together. Such a condition may be illustrated by the two white strains of sweet peas crossed by Bateson which produced purple flowers in the first (F_1) hybrid generation, and purple, pink, mixed, and white flowers in the second (F_2) hybrid generation. New combinations occur, but there is no evidence of increase in unit characters, nor is there an actual increase in variability.

Turning for a moment to size characters, the influence of cross breeding or conjugation is of decided interest inasmuch as facts bearing on the solution of the problem as to how size may be increased to the phys-

iological limit, even though the results hold for a single generation, have the greatest practical value for the future of agriculture and animal breeding.

It should first be noted that size in a unicellular organism is dependent on the absolute size of the individual cell with a limit undoubtedly imposed by laws governing the ratio between volume and surface in connection with osmosis. In multicellular organisms, however, size characters may depend upon either the size or the number of the component cells or upon both factors. This distinction possibly explains an apparent diversity in results obtained in the two groups.

Darwin, Mendel and others who have seriously considered the question have recognized that hybrids, among plant forms in particular, usually grew to a larger size than either parental form, a result probably due to the increased rapidity of cell division and consequently greater number of cells as conjectured by East. In the study of zygospores of *Spirogyra* it was therefore noticed with some interest that the cross-bred forms were smaller than the close-bred forms so far as both length and volume were concerned. Jennings (1911) in his study of *Paramecium* reached a contrary conclusion, stating that "The progeny of conjugants . . . were a little larger than the progeny of non-conjugants and the difference appears to be significant." This is correct merely in reference to length, however, and that it is not true for actual size as indicated by volume is evident on applying the formula for the volume of a prolate spheroid ($V = 1/6\pi ld^2$) by which it may be demonstrated that the non-conjugant forms, while smaller than the others at the beginning of the experiment, actually became larger. Thus in agreement with the zygospores of *Spirogyra*, conjugation decreased size.

The question immediately occurs as to the cause of the increased size and vigor among cross-bred multicellular organisms when the evidence indicates that cross-bred unicellular forms are smaller instead of larger. Some investigations that I have undertaken indicate an answer apparently meeting the conditions. While sufficient control experiments have not been made to venture more than a provisional opinion, the data suggest that the cells of cross-bred multicellular organisms are actually smaller than the cells of inbred or pure line forms, and that the more rapid division is a function of the greater ratio surface has to volume in a small cell with the better opportunity thus obtained for increased metabolism.

That there is need of further investigation on size and variability in pure lines and in cross-bred forms through the application of statistical methods in connection with the maintenance of pedigrees through long series of generations seems evident. Eventually theories will make way for facts which will allow a proper perspective.

IV

Where do the results presented in the preceding pages lead us? Does their value, so far as their bearing upon the production of new and transmissible characters that will build up an organism in a required direction, consist merely in the formulating of hypothesis after hypothesis which as investigations proceed will in turn make way for other hypotheses equally transient? Or, on the other hand, do they mark a definite progress along the lines we are endeavoring to follow, namely, the control of evolution.

Before attempting a reply which must prove more or less unsatisfactory to those looking forward to immediate results, it seems advisable to pause for a moment and in the light of the preceding discussion con-

sider the types of differences—variations—which exist in so far as they may effect the result with which we are chiefly concerned.

Beginning at an early period in the history of evolution with the idea that all variations might be inherited, results soon suggested that the characters due solely to surrounding influences such as food supply, etc., were not thus transmitted. These were called *fluctuating variations.* On the other hand, variations due to the structural changes in the germ cells which were passed on from one generation to another have been spoken of as *inherited variations.*

The evidence at present indicates that farther subdivisions must be made and that normal inherited variations consist of two quite distinct classes. The variations where the results are due to the interaction of factors in accordance with Mendelian principle, and which, adapting a term used by Plate (1913), may be called *amphimutations* inasmuch as the condition is due to the mingling of two lines of descent, the other variations, as a class, in which the results —evolution in the abstract—are due to a series of units added as increments, may well be called *cumulations.* It is quite evident that the term "mutation" can not continue to include both types. As a coordinate term fluctuating variations may be spoken of as *fluctuations.*

Under abnormal variations must be classified forms ranging from monstrosities to slight departures from the ordinary condition, some of which are undoubtedly due to the losses or modifications of unit characters through the action of extraordinary stimuli, while others may be due to abnormal and unequal distribution of chromosomes occurring at the time of their division. The *idiomutations* of Plate are here included.

The answer to the question as to the progress made in the application of evolution to the creation of new forms rests in the statement that the attack on the problem is becoming more concentrated. The selection of fluctuations has been tried and has failed. Efforts by means of amphimutations end in a maze of circles with no evident progress. *Idiomutations,* so far as one may judge from the evidence, present retrogression rather than advancement. It is by means of pure lines under normal conditions that one may search with advantage for cumulations, the units by which to build the new. There the evidence will be unobscured either by the pyrotechnics of Mendelian formulæ, or by the factitiousness of abnormal stimuli. Fluctuations will be present, but statistical methods will permit their evaluation. Should the measurement of the mean in the tenth or even the one hundredth generation present no advancement, failure is not necessarily implied. Nature has devoted fifty millions of years or more to her work. There should be no discouragement if a few paltry years of investigation fail in duplicating her methods.

It is with a feeling not unmixed with pessimism, however, that one views the conditions under which work of the character outlined must evidently go forward. Those engaged in teaching have with a few exceptions time for little more than an occasional investigation of limited scope, particularly in a field which requires continuous application. Governmental departments where it could best be taken to a successful issue have only too often been subservient to political policies which demand immediate results. An ounce of compiled compendium is—to them—worth more than a ton of painstaking investigations which makes an advance on a theory. Looking a few generations into the future is not their concern.[6] A remedy for such conditions clearly

[6] Exceptional work has been done by those more or less closely connected with certain State Agricultural Experiment Stations. The names of East and

lies in endowments either in connection with universities, or through the establishment of the specialized private institution.

That the problem of applied evolution will eventually be solved there can be no doubt. That it will occur in our generation may only be expressed as a hope.

L. B. Walton

Kenyon College,
November 16, 1913

THE MUTATION MYTH

It has long been recognized both on the botanical zoological sides, that sterility is a notable characteristic of species crosses or true hybrids. Where species are nearer to one another their resultant cross is naturally less sterile than when their affinity is more remote. In the case of plants it is usually particularly easy to trace even slight evidences of previous hybridization in the sterility and abortive character of some of the spores or pollen. In contrast to hybrids, genetically pure species are characterized by pollen grains or spores, as the case may be, which are all perfectly developed. I have satisfied myself by a very extensive study of the spores and pollen of liverworts, mosses, ferns (including numerous genera of all the important families, isosporous and heterosporous), lycopods, selaginellas, quillworts, lepidodendroids, equiseta, cycads, ginkgo, conifers (including numerous genera of all the tribes), gnetales (all the genera) and many dicotyledonous and monocotyledonous angiosperms, that in good species the spores or pollen is invariably perfect morphologically, that is fully formed and having normal protoplasmic contents. Known hybrids on the contrary are characterized by a greater or smaller number of abortive spores, which have little or no protoplasmic contents. This conclusion is by no means new but the wide range of facts examined in the present connection adds very materially to its strength. It has been further noted that so far as morphological conditions are concerned, plants of genetic purity, even when grown under extremely abnormal conditions, as exotics in greenhouses, etc., have perfect spores or pollen. For example a conifer or a cycad from Australia or Japan, grown in the hothouse and producing its pollen in the winter season, still shows the grains normally developed morphologically, whatever may be their physiological inefficiency.

Hayes, of Connecticut, Pearl, of Maine, Emerson, of Nebraska, Dean Davenport, Rietz and Smith, of Illinois, are familiar to all interested in the application of the principles of evolution. One often conjectures, however, as to the extent to which some of the most valuable contributions are in reality "by-products" of investigations meeting the approval of the "Missouri" type of legislator.

The bearing of the facts indicated in the paragraph above is of great importance in relation to the mutation hypothesis of De Vries. This distinguished Dutch plant physiologist, a little over a decade ago, published a series of observations and generalizations under the title of "Die Mutationstheorie." His notable offering was the statement that material of a species of *Œnothera* or evening primrose, referred by him to Seringe's *Œnothera lamarckiana,* found growing spontaneously near Hilversum in Holland, was producing annually new species or as he preferred to call them, elementary species. In 1904 Professor De Vries was invited to lecture in the University of California on his sensational discoveries. The lectures were edited and published later by the director of the Desert Laboratory of the Carnegie Institution of Washington, with the title of "Species and Varieties, Their Origin by Mutation." Dr. MacDougal thus became both in fact and figuratively, the "*vox in deserto clamantis,*" the baptist of the gospel of mutation. His exploits with the syringe in the baptism and production of new species of plants by intraovarial injections appear further to render his claims in this direction beyond question. As secretary of the Botanical Society of America and by his repetition and elaboration of De Vries's cultures of *Œnothera,* he has done unquestionably more than any one else to diffuse the doctrine of mutation in North America. It has in fact become so widely accepted on our continent, that it has in many instances

been unfortunately introduced even into elementary courses of botanical or biological instruction. Europe has presented a marked contrast to America in this respect, for here the mutation hypothesis of De Vries has been coldly received. It seems clear however that the European attitude is more in accordance with the established principles of biology than our own.

The distinguished English geneticist Bateson was apparently among the first to point out that in all probability *Œnothera lamarckiana* was a hybrid, as shown by the partial sterility of its pollen. Dr. MacDougal countered by the statement that he had found abortive pollen in specimens of *O. biennis*, growing in the vicinity of the city of New York. This he apparently regarded as a sufficient reply to Professor Bateson's criticisms. More recently a number of American students of plant genetics have cast doubt on the genetical purity of De Vries's *Œnothera lamarckiana*. Among these may be mentioned Davis, East, Emerson and Gates. The attitude of the last investigator is not the less significant because he was in the first instance a convinced mutationist of the De Vriesian school. In the case of the mutation hypothesis, we find again what is apparently an all too common condition in the case of biological theories, a neglect of fundamentally important morphological evidence. There seems to be absolutely no doubt, on morphological grounds, that not only is *Œnothera lamarckiana* of hybrid origin; but that the Onagraceæ, to which it belongs, are somewhat generally contaminated by spontaneous hybridism.

I have delayed publication of my conclusions in regard to the genetical status of the Onagraceæ, in the hope that some other morphologist would lay bare the extremely insecure foundations upon which the imposing superstructure of the mutation hypothesis has been raised. About eight years ago cultures of *O. lamarckiana* and its mutants were started at the Harvard Botanic Garden from seeds supplied by Professor De Vries. *Œnothera grandiflora*, which was of special interest in connection with the mutation hypothesis, was likewise grown from seed supplied by Professor S. M. Tracey who made a special visit to Tensaw to obtain it for me. Shortly afterwards other work became more pressing and monopolized all available time. The cultures and seeds were accordingly turned over to Professor Bradley M. Davis, who was residing in Cambridge at that time. Dr. Davis has published a number of papers on hybridization work with *Œnothera* species and I have supplemented my original stock of preserved material from specimens kindly supplied by him.

Some illustration of pollen conditions in known hybrids other than Onagraceæ will first be considered. Many of our improved horticultural plants are known to have originated by hybridization, while others more anciently cultivated by our species are suspected of hybrid origin. Taking only the known hybrids as illustrations, such as tulips, irises, narcissus, lachenalia, freesia, etc., etc., we find that although many of the pollen grains are perfectly developed both as regards external form and internal contents, a greater or smaller proportion are small, shrivelled and nearly or quite devoid of protoplasm. In the case of genetically pure species of these genera the pollen grains on the contrary are all alike and perfect. In normal species, even when long in culture and under hothouse conditions the pollen has proved in all the cases examined in the present connection perfectly sound. This is notably the case for example with the common easter lily. The effect of hybridization is equally clear in the case of the Dicotyledons. Our pinks, calceolarias, nasturtiums, etc., are often of known hybrid origin and show clear evidence of such derivation in the condition of their pollen, which is more or less abortive. President Brainerd, of Middlebury College, has in recent years made some interesting observations on spontaneous hybrids of our native violets. He has found numerous forms of these, significantly described by certain systematists as new species, to be in reality hybrids, as shown by their characters clearly intermediate between recognized species and by their Mendelian segre-

gation in cultures. Professor Brainerd has been kind enough to supply some flowers of these interesting specimens for the present work and the pollen conditions are clearly those found in hybrids.

We may now profitably turn our attention to the Onagraceae, to which the well-advertised *Œnothera lamarckiana* belongs. Our common garden fuchsias are known to be of hybrid origin. In some of the varieties the pollen sterility is almost complete. This is notably the case in a hybrid derivative of *Fuchsia triphylla*, grown in the Harvard garden. In other varieties the sterility is often less marked. This condition has been found to obtain for example in long-tubed fuchsia hybrids. Here a certain number of the grains are perfectly developed and have normal protoplasmic contents, while others are small, shrivelled, collapsed and without protoplasmic contents. Among the wild-growing species of the Onagraceæ, those of *Epilobium* have long been recognized by European systematists as prone to produce spontaneous hybrids. A good illustration in the present connection is supplied by a hybrid form of *E. hirsutum*, occurring commonly in the vicinity of ballast heaps. Here the pollen is to a large extent abortive, the degeneracy sometimes affecting the whole of the contents of the anther sack or in other cases being confined to a greater or smaller number of the grains. In contrast to *E. hirsutum* may be mentioned our common fireweed, *E. angustifolium* (sometimes put under a different genus). In all the abundant material of this species examined the pollen was entirely normal. Indications of hybridization correlated with corresponding pollen conditions have also been noted in the case of other representatives of the Onagraceæ, but the illustrations mentioned will suffice for our present purposes.

We may now turn to the genus *Œnothera* itself. In his "Mutationstheorie" De Vries has noted that about one third of the pollen of *O. lamarckiana* is sterile, and abortive. This statement I can only confirm. Even in the more vigorous of the so-called mutants originating in cultures of *O. lamarckiana* from the seed, the pollen is very largely degenerate and in the less vigorous elementary species often almost completely so. In *O. lata* (mutant of *O. Lamarckiana*) the pollen is frequently entirely sterile. But it is not only in *O. lamarckiana* and its so-called mutants or elementary species, that pollen sterility is to be seen, for this condition is well nigh universal in the species of this Onagraceous genus, recognized in systematic works. For example in the very common and variable species known as *O. biennis*, half of the pollen grains are sometimes abortive. This condition I have observed in specimens from regions as far apart geographically as the state of Massachusetts, the province of Ontario and the shores of the Gulf of St. Lawrence. The examination of a large amount of material of recognized wild species of *Œnothera* has led me to the apparently inevitable conclusion that spontaneous hybridism is extremely common in the genus and that in general it represents a condition of high genetical impurity. The purest species which has come under my notice, so far as may be judged from the pollen conditions is *O. grandiflora*, obtained from Tensaw. Here pollen abortion is well nigh absent both in flowers gathered for me by Professor Tracey and in those produced from seed both by Professor Davis and myself. Continued growth in the Harvard botanic garden has not altered this characteristic in any degree, for specimens grown last summer show the same condition of relative genetical purity or at least freedom from inharmonious hybridization.

It may be argued by some that the more or less marked constancy of the generally accepted species of *Œnothera* makes it clear that they are normal species. It is now recognized however that constant hybrids are of extremely common occurrence both in nature and as a result of experimental crossing. This is particularly true of species crosses. There is consequently no good reason why we should not admit that the genus *Œnothera* is strikingly characterized by spontaneous hybridization. There appears in fact to be every reason to believe that the bar sinister has been crossed and double crossed in our American

evening primroses. The extensive studies which I have made on the pollen and spore conditions in the higher plants from the mosses upwards, which will be detailed and illustrated elsewhere, make the conclusion apparently unavoidable, that the Onagraceæ in general and the genus *Œnothera* in particular, are peculiarly subject to spontaneous hybridization in nature. It follows of course that no genus or group of plants could have been more unfortunately chosen to illustrate the origin of species by mutation or saltatory evolution. Obviously we must in the light of the considerations advanced above, interpret the variability of the seedlings of *Œnothera* species, particularly of those of *O. lamarckiana* of De Vries, as evidence of ancestral hybridization, on the evidence of the very significant pollen conditions revealed both by the genus under discussion and by many members of the family to which it belongs.

The mutation theory of De Vries appears accordingly to lag useless on the biological stage and may apparently be now relegated to the limbo of discarded hypotheses. The zeal, industry and insight of the distinguished plant physiologist of Amsterdam can not be too highly appreciated. Even although his hypothesis must apparently be given up both on morphological and genetical grounds, it has nevertheless been the cause of a great deal of valuable work, which will remain after the motive of it has disappeared. The present refutation has been undertaken in the interest of biological progress in this country. It is now high time, so far as the so-called mutation hypothesis, based on the conduct of the evening primrose in cultures, is concerned, that the younger generation of biologists should take heed lest the primrose path of dalliance lead them imperceptibly into the primrose path to the everlasting bonfire.

Edward C. Jeffrey

Harvard University

DEMOCRACY IN UNIVERSITY ADMINISTRATION[1]

A discussion of the topic assigned to me in this conference might be as brief as the famous chapter on snakes in the Natural History of Iceland, or, to use a more modern instance, as a review of Mr. Taft's activities in subversion of the courts and the constitution. There is no democracy in university administration. But we can consider the conditions and the remedies.

The situation of a teacher has aspects inherently undemocratic. He has arbitrary authority over the conduct and intellectual life of his students, and is paid by superior officials to discipline and teach as they prescribe. The professor may lecture to his classes "als dictirt euch der heilig' Geist," and in other academic relations may realize that silence is silver and flattery gold. To be half tyrant and half slave does not strike the average of a free man. The pedagogue may be expert in his narrow field, while he is segregated from the larger life of his fellow men. His salary is safe and small; his clothes are black and threadbare; he is very respectable, but only half respected. The inevitable difficulties we emphasize by providing on the one side a system of education which does not carry its own appeal and must be enforced by examinations, grades, degrees, compulsory attendance and the like, while on the other side a system of administration has developed which puts the professor in a position of personal dependence. He is not only unfree in the sense of the domestic servant, whose wages, work, company, habits and Saturdays off are set by the employer, but he is also unfree in the sense of the slave in that he is held to his place by forces that he can not resist. This may be in part caricature, like the typical professor of the novel or play who hunts beetles, while his daughter or wife engages in flirtation, but a caricature may depict and enforce the truth.

A less obvious but equally undemocratic aspect of the academic career is due to the fact that the university professor earns his living by teaching and the conduct of academic routine, while society depends on him

[1] Read at the conference on "The Relation of Higher Education to the Social Order," arranged by the council of the Religious Education Association, Yale University, March 5, 1914.

for productive scholarship and scientific research. Three quarters of the scholars and men of science in this country hold academic positions. Services to individuals can be paid for by those benefited, but we have no machinery in a democracy by which services to society are paid for by society. Public service can thus be rendered only by those who can spare the time, and is rewarded by recognition, reputation, honors, etc. Under aristocratic institutions men of inherited wealth may serve without salaries as members of parliament, magistrates, university chancellors, scientific men, scholars and the like, and may have their reward in social recognition, titles, membership in exclusive societies and similar non-rational sanctions. These by-products of oligarchy are its historical justification; responsibility for public service is placed on those who have wealth and privilege. But in a democracy power and wealth, in so far as they are desirable, should be the rewards of public service, not its prerequisites. Trustees of universities and members of school boards who serve without salaries are likely to render services about equal in value to the payment they receive.

Amateur work, whether by the man of wealth or by the teacher, becomes increasingly ineffective as the boundaries of knowledge are enlarged. The university instructor, impelled by sheer love, carries on a research, getting the time by working between hours and after hours. But he can not complete it or put it in its place in the orderly development of the science. He hopes to do so in the summer, but family bills accumulate, and he must engage in the sweat-shop labor of the summer school or some hack work. The research becomes cold, perhaps something of the same sort is done elsewhere, it is published in a slovenly way or not at all. I have somewhat recently had the privilege of visiting the Bureau of Standards, the Rockefeller Institute for Medical Research and the Research Laboratories of the General Electric Company. Here we have three institutions, conducted, respectively, by the government, under private endowment, and by an industrial concern, beside which the laboratories of physics, chemistry and physiology in our best universities are distinctly amateurish and inferior.

The men in these institutions have larger salaries and better facilities for their researches than are given in the universities; but their great advantage is that they are investigators by profession paid directly for the work they do. The professor, paid for his most important work in the fiat currency of reputation and petty honors, is in a position completely undemocratic. It is no wonder that we have the *demitasse* storms of academic politics and social life. There is one thing more absurd than for professors to march in processions in the order of their dignity advertising by brightly colored gowns and hoods the degrees they have received, and that is to make the financial reward of scientific and scholarly work transfer to an executive position which prevents doing such work thereafter.

The undemocratic aspects of our academic life are almost wantonly enhanced by the position attained by the president with the ensuing hierarchy of deans, heads of departments and other officials. The extraordinary material development of the country, with no balanced aristocratic system, has led to excessive power in the hands of a few individuals, whether in politics, in business, or in educational work. Every sensible person believes in individual initiative and individual responsibility. The safety in a multitude of counselors is usually due to the one who does the job. Government is a rough business, and this holds to a certain extent for educational institutions. The university or college president must do the best he can under hard conditions, and it is no wonder that he takes as much power as he can get. He has at least six masters—the trustees, the faculty, the students, the alumni, the general public and the bearers of the purse—not to speak of his wife's social and his own political ambitions. Each of them has different and discordant interests and ideals. It is not surprising that he finds it troublesome to ride these various horses and sometimes

> . . . moves in a mysterious way
> His wonders to perform.

The difficulty is that if an autocrat obtains unlimited powers, whether in the nation, the state, the city, the family or the university, he does not always prove to be wise and benevolent, and it may even be argued plausibly that the wise and benevolent despot is the worst kind, for he works the greatest demoralization. It is true that in a democracy we can afford to give large power to our leaders, for they are subject to the popular will. In the British democracy the monarch can only be permitted to be a social ornament, as he is there for life and his son after him. In our American democracy the president of the nation has extraordinary influence, but he can only maintain it so long as he reflects public sentiment. In Great Britain the cabinet is directly responsible to the parliament, and represents in its constitution the diverse elements of the majority, the prime minister not being necessarily the one most influential. This method is more democratic than ours, and in my opinion preferable. We have tried it with tolerable success in the commission form of government adopted by a number of cities. This is also at the present time being used in several colleges and universities, but not much can be expected here so long as it is a temporary expedient to last only until a president can be found.

It may indeed be seriously questioned whether the superior initiative and efficiency which one-man power is supposed to have is not more than counterbalanced in a university by the loss of these traits in the subordinates. A superman requires as his correlative many undermen. It is almost impossible to supervise the teaching and research of professors. Such an attempt is charmingly portrayed by President Maclaurin of the Massachusetts Institute of Technology in connection with the report on academic efficiency of the Carnegie Foundation:

> The superintendent of buildings and grounds, or other competent authority, calls upon Mr. Newton:
>
> *Superintendent:* Your theory of gravitation is hanging fire unduly. The director insists upon a finished report, filed in his office by 9 A.M. Monday next; summarized on one page; typewritten and the main points underlined. Also a careful estimate of the cost of the research per student-hour.
>
> *Newton:* But there is one difficulty that has been puzzling me for fourteen years, and I am not quite. . . .
>
> *Superintendent* (with snap and vigor): Guess you had better overcome that difficulty by Monday morning or quit.

The sinister side of the president's control of the professor is shown in two cases which have recently become public property. At Wesleyan University the professor of political science and sociology was compelled to resign after some remarks on the observance of the Sabbath and, at Lafayette College, the professor of philosophy and psychology was dismissed because his teaching was thought not to be in accord with the stricter standards of the Presbyterian church. We are not here concerned with questions of academic freedom or of permanance of tenure, but only with the methods of determining what the professor may say and how he shall be dismissed. As a matter of fact, in these two cases the alleged infractions of orthodoxy were slight. Several clergymen have told me that they might very well have made the remarks of the Wesleyan professor, and the Lafayette professor remains a Presbyterian clergyman in good standing. At Wesleyan, the president asked for an explanation of the remarks of the professor, demanded his resignation and accepted it, the three letters being written on the same day without the possibility of official consultation with the faculty or trustees. The fact that in this case the alleged ground for the dismissal was not the real cause does not improve the situation. At Lafayette, in like manner, the president wrote to the professor demanding his resignation in view of the supposed contents of a course. In this instance the professor was given a hearing before the trustees, but the president was naturally upheld.

A distinguished army engineer has recently stated that he would not accept the commissionership of police for New York City unless

the law should be changed so that a policeman might be dismissed without the right of appeal to the courts. It is supposed to be a part of the moral etiquette of the New York police to commit perjury in defense of one another, and it may or may not be that arbitrary power would for a time be desirable. But an army officer has no such control over his subordinates, who can only be court-martialed after definite charges and trial. One result of the difference between the police system and the academic situation is that no one can question the personal courage of the police. Whether it is better to lie like a policeman or to run to cover like a rabbit need not be argued, as it would doubtless be agreed that conditions should be such that this is not the necessary alternative. The slur about the third sex in America is unwarranted, but it would be better if there were not enough smoke to give rise to the alarm of fire.

Professors in the better institutions are not often dismissed because they or their views are not in favor with tho administration, though this happens much more frequently than it becomes known, for the professor is naturally disinclined to drag the "pageant of his bleeding heart" across the continent and have his name put on the employer's black list. But it is this publicity which is his safeguard; and we have exercised by the body of professors and the general public a real democratic control, to which the president and trustees must submit. Stanford University has not recovered in thirteen years, and will not recover in another generation, from the loss of prestige due to the dismissal of Professor Ross and its sequelæ. Departments of economics and sóciology in leading universities would not recommend a successor to Professor Fischer at Wesleyan, and public spirited men would not accept the position. At Lafayette, the resignation of the president has followed promptly the publication of the report of the American Philosophical and Psychological Associations on the dismissal of Professor Mecklin. On the other hand, Harvard maintained its high position by promptly offering lectureships to Professor Ross and Professor Fischer.

But while professors are not often dismissed because the president does not like their teaching or their personality, the possibility is present every day with a resulting demoralization not easy to estimate. Even more serious is the fact that the president may be responsible for the appointment and promotion of instructors and professors, and for increases in salary—for salaries are sometimes increased, however remote this contingency may seem to most professors. Semi-secret increases in salary by favor of the president must be regarded as intolerable. It tends to divide those who suffer under it into three classes—courtiers, quietists and rebels. The courtiers are those most likely to flourish in the system to its ultimate collapse.

I have had the privilege of proposing and seeing adopted by the trustees of Columbia University a change in the statutes in the direction of social democracy. We had long had, like some other institutions, provision for a sabbatical leave of absence on half salary. But in practise it proved that the sabbatical year was usually claimed only by those professors who had independent means or no family; it was thus a case of class privilege. Five years ago the statutes were altered to allow the alternative of a half-year leave of absence on full salary. This gives the professor some eight months for travel and research without loss of salary, and the institution sacrifices no more than on the half-salary basis, except in so far as more professors benefit. The plan deserves adoption in other institutions, and may properly be mentioned in a paper concerned with democracy in the university. It also gives opportunity for the frivolous remark that it might be an advantage if the statutes of a university provided for leave of absence of the president so often as he liked on double salary.

We do not know whether the progress of civilization has in the main been due to great men who have directed it, or whether these are essentially by-products and epiphenomena of social and economic forces. It is, therefore,

no wonder if we can not decide categorically whether or not it is well to have in the university one leader whom the rest of us will follow. But it is probably undesirable, as it is certainly undemocratic, to have a boss who drives us. This is the fundamental difficulty in our present university organization. The president is responsible to the trustees who in the private corporations are responsible to no one. The deans and heads of departments are responsible to the president who names them, and their subordinates are responsible to them. This department-store system reverses the correct or, at all events, the democratic direction of responsibility. The department or group should name its head and those to be added to it. The teachers or professors should name their deans and their president who should be responsible to them. The trustees should be trustees, not regents or directors. Their relations should be with representatives of the faculties, not exclusively with a president whom they appoint and who in practise is likely to select them.

It may be that the high-tide of presidential autocracy in our universities is now ebbing. At any rate we are discussing the problem more freely than in the past. I have obtained and published opinions of some three hundred professors who have done scientific work of distinction. These exhibit a very wide-spread dissatisfaction with the existing system. There is naturally much difference of opinion as to the remedies, but five sixths of them favor reforms in the direction of greater faculty control and less presidential autocracy. The remaining one sixth are mostly executive officers or men in institutions where the faculties have more than average influence. Thus the great university now entertaining this conference has maintained the better traditions. It has been said that if the faculties name the professors, there will be inbreeding and deterioration. To this it may be replied that Yale is represented in the National Academy of Sciences by eleven members; Cornell and Pennsylvania, with twice as many students, each by one member.

Harvard, like Yale, has maintained a measure of faculty and alumni control. President Eliot, whose masterful personality has been influential in exalting the presidential office, has at home deferred more to the corporation and overseers on the one side and the faculty on the other than lesser presidents. The plan adopted at Harvard of promotion after a fixed term of service with uniform increments of salary and permanence of tenure for the full professor removes him from the most humiliating relation to the president. At Cornell the faculties have been granted the right to elect their deans, and President Schurman advocates faculty representation on the board of trustees. At Princeton the departments have been authorized to recommend appointments and promotions, and a committee elected by the faculties meets with a committee of the trustees, this latter plan being in my opinion the most feasible method of improving the academic situation. Other reforms at various institutions in the direction of greater faculty control might be cited, the most striking and recent being the referendum vote of confidence obtained from the faculties by the president of the University of Illinois.

Whoever or whatever may be the occasion of reforms in academic control, the real cause must be the sentiment of the professors, and this can only be developed and expressed by proper organization. I am proud to belong to an association that at two consecutive meetings has taken action exhibiting a group consciousness of this kind. A year ago the American Psychological Association unanimously passed a resolution proposed by me to the effect that it is undesirable for its members to accept work in summer-schools or extension courses in which the pro rata payment is less than their regular salaries. Last Christmas at New Haven the association took the action to which reference has been made on the dismissal of the professor of philosophy and psychology from Lafayette College. An influential committee of one hundred on research has been formed by the American Association for the Advancement of Science. It may be that the time has now come when an association of American university professors might be or-

ganized, similar to the medical and bar associations, which would be an influential force in improving the conditions under which our work is done. It should not be forgotten that the maintenance of high standards in the university is as important for the community as for the professor, and his efforts on its behalf are by no means narrowly selfish. The future of the American university does not depend upon its machinery, but upon its men. The danger of a bad system is that it may gradually demoralize the spirit and ideals of the men working under it, and may keep from it or drive from it the kind of men who are needed.

When a speaker has only twenty minutes in which "to set the crooked straight," he can not be expected to devote much time to explaining that it is not so very crooked and is made of sound timber. The university is the noblest monument which we have inherited from the past and at the same time the most powerful engine driving forward our civilization. We owe to it the tribute of truth and the duty of service. It is our part to make it a democracy of scholars serving the larger democracy to which it belongs.

J. McKeen Cattell

CALVIN MILTON WOODWARD

Calvin Milton Woodward was born in Fitchburg, Mass., on August 25, 1837. He was graduated from Harvard in 1860 with the degree of A.B. and with the honor of membership in Phi Beta Kappa. In 1905 Washington University, and in 1908 the University of Wisconsin, conferred upon him the degree of LL.D.

During 1860–65 he was principal of the Newburyport, Mass., high school. In 1862 he was granted leave of absence for one year. During this period he served first as lieutenant and then as captain of a company in the 48th Massachusetts Volunteers. His regiment helped patrol the Mississippi in Louisiana and was under fire in the siege and storming of Port Hudson.

In 1865 he came to St. Louis, where in the service of Washington University and of his adopted city and state he passed the last forty-nine years of an active, energetic and fruitful career. At first he was the vice-principal of the academic department. In 1866 he was doing college work and was principal of the O'Fallon Polytechnic Institute. In 1868, under the authority of the university corporation, he began the organization of an engineering department. In 1870 he was made Thayer professor of mathematics and applied mechanics, and dean of the polytechnic faculty. In 1880 the St. Louis Manual Training School was opened, with Dean Woodward, its organizer, as director, and immediately it became the educational novelty of St. Louis, and for that matter, of America.

From this time, with some minor changes, he held until 1896 the positions of Thayer professor of mathematics and applied mechanics, dean of the engineering school and director of the manual training school. He resigned the deanship in 1896, but resumed the duties of that office in 1901 and again from that time carried his threefold official title until his final retirement from active service in the summer of 1910. He had remained in the harness until the close of his seventy-third year, when he retired upon the Carnegie Foundation. "His eye was not dim and" apparently, "his natural force was not abated." Four more happy years came to him in literary work, on educational boards and in the free use of his time and talent in the lecture field. On January 10, just passed, he was actively at work in behalf of a philanthropic enterprise which had deeply interested him for two or three years when the cerebral lesion attacked him which on January 6 proved fatal. After a private funeral service at the house, January 12, there was held at the church of which Dr. Woodward was an active member a memorial service at which Dr. Dodson, his pastor, Mr. Langsdorf, his pupil and colleague, as well as his successor as dean, Mr. W. A. Layman, president of the Wagner Electric Company, and Mr. Ben. Blewett, city superintendent of public instruction, spoke of his services to society, to the university, to mod-

ern scientific and civic progress and to general education.

Through all his busy years he lectured frequently in America on educational and scientific subjects and on special occasions in England. His contributions were numerous to periodicals and to the proceedings of the many learned societies of which he was a member. He was the author of two volumes upon manual training, one published by Heath & Co., the other in London and afterwards by the Scribners. During the years of his retirement he has written and published a notable text-book of more than 500 pages upon rational and applied mechanics. Every page shows the mature teacher and the clear logician reasoning with his students. Though published last year, the work is about to pass to a second edition.

It was fortunate for Mr. Eads, and for the engineering fraternity as a whole, that, from the bold inception to the triumphant completion of the St. Louis bridge, Dr. Woodward, then an enthusiastic young professor in his thirties, watched every operation and knew the great work to the minutest details. He went to the bottom of the piers, where men were working under more than four atmospheres of pressure. He was among the first to walk the plank connecting the approaching ends of the big middle arch. He knew the designs, drawings, contracts and unusual tests of material. With some of his students he was a passenger on one of the fourteen locomotives that tested the structure. When the work was done, which to this day stands in a class by itself, Captain Eads entrusted to Professor Woodward the task of writing the history of the achievement. This record occupied two busy years and remains an enduring monument to its author and to James B. Eads. At the time of its appearance it was said to be the most important contribution to engineering literature that had appeared in America. The book is widely distributed among the scientific libraries of the country; but the original edition is nearly exhausted and another will probably never be printed.

About that time, Professor Woodward, impelled by the serious needs and deficiencies of those of his students who were ambitious to become engineers, conceived and developed the manual-training idea. Upon this phase of his work it is not necessary for us to dwell. The innovation had many and bitter enemies, for it was not then apparent how manual training could help in making educated men. But a large section of the educational world in America now believes in it and has adopted it in many secondary schools as one element in the formation of the efficient citizen.

At a critical time in the development of the University of Missouri Dr. Woodward was a curator and president of the board. His service at that time to higher education in his state will never be forgotten. While the Louisiana Purchase Exposition was in progress at St. Louis, Dr. Woodward was president of the Aeronautical Congress which did much to create a strong faith throughout the country that the conquest of the air was near at hand, and he himself made important contributions towards the solution of the problem.

In 1894 Dr. Woodward was president of the Society for the Promotion of Engineering Education, and in 1909–10 he was president of the North Central Association of Colleges and Secondary Schools, the first time in the history of that useful organization that a college professor not of presidential rank presided over its deliberations.

Dr. Woodward was chosen president of the American Association for the Advancement of Science for the meeting of 1906. That the choice was a happy one no one could deny who was fortunate enough to be present at the opening session in New Orleans. Since the Civil War this was the first visit of the American Association to a southern city. Southern hosts and northern guests vied with each other to make the occasion a delightful one. As usual the first formal session of the meeting was given up to courteous welcomes and responses. The splendid way in which President Woodward rose to the possibilities of graceful speech none of those present will ever forget.

Dr. Woodward served his city conspicuously

in many matters pertaining to its growth and development. At one time the city census was questioned and he was chosen superintendent to repeat and verify it. He was always ready and forcible in the discussion of the engineering problems of the city, and served terms as president of both the St. Louis Engineers Club and of the St. Louis Academy of Science. As a member of the city school board and several times as its president, he has given character and direction to the public school system of St. Louis.

Professor Woodward married Fanny S. Balch, of Newburyport, Mass., in September, 1863. She survives him together with three daughters, two of whom are married. His home life was an ideal one; to enter within its circle was always a privilege.

In hasty review we have selected only a few of the instances where Calvin Milton Woodward has come prominently before the country. The story of a long life of cheerful labor and distinguished service in the college halls can never be told. There is no tangible record of the daily lessons enforced with an unfailing and overflowing spirit of optimism. But it is this work and this spirit that produce a sure and lasting effect upon the lives of students. Just as the gentle sunshine is the most potent force in nature, so the efficient teacher, who on the whole is quite often an object of condescending sympathy in our social state, is nevertheless the mightiest agent in the progress and development of society, for he is developing its coming leaders and, therefore, more than any other agency, is shaping its destiny. Happy is that teacher who knows his power and lives true to his high calling. His name may soon be forgotten, but the essence of his life and labor passes on from heart to heart and from generation to generation.

Such a man was Dr. Woodward. As a teacher he lived. As a teacher he sought his life's reward. A little more than a year ago in a company where were many of his former students he expressed his conviction that no epitaph could more highly honor him than the simple statement "He was a teacher of men."

O. A. Waldo

Washington University,
St. Louis

ROBERT KENNEDY DUNCAN

By the death on February 18 of Dr. Robert Kennedy Duncan, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, American science lost one of its most illustrious devotees. Dr. Duncan was known to the public at large in two important lines of service. First, as an interpreter of science, in which branch he was preeminent; he gave life to the most abstruse things of cold science and made them of intense interest. His books, "The New Knowledge," "The Chemistry of Commerce" and "Some Chemical Problems of To-day," while of the highest scientific accuracy, are so written as to hold the reader's sustained attention to the end. The other line in which he will be remembered is as the originator of the unique system of *the service of science to industry*. Dr. Duncan felt that he was fortunate in being able to live to see this system established on a permanent basis in the Mellon Institute of Industrial Research. With his usual farsightedness he carefully trained those who were to take his place when he was gone and the institute embodying the system he originated will go on as a living monument to its founder.

Certain of the ideas he had in mind in working out a practical method whereby the learning of the university could be brought to the service of industry are interesting, in that they show prominent traits of his character. He once told me that he experienced the keenest pleasure of achievement when he thought of the opportunities he was able to offer to young men through the working of this system. He loved to speak of his laboratory as a center of opportunity for young men. And that fact really indexes the keynote of his character. He was absolutely unselfish. He sought nothing for himself and was continually trying to advance his "boys,"

as he loved to call them. And he was in his relations to them an older brother more than a formal director. Dr. Duncan always felt that in scientific investigation the things of the spirit were more important than material things and that the many seemingly impossible results which had been achieved in his laboratories were accomplished solely because of the fine spirit which he instilled into his men.

Dr. Duncan was born in Brantford, Ontario, 1868. He graduated with first-class honors in chemistry and physics from the University of Toronto in 1892 and did graduate work in Clark and in Columbia universities. He was a preparatory school teacher of chemistry from 1893 to 1901, when he became professor of chemistry at Washington and Jefferson College (1901–6). He studied abroad during the years, 1900–1903, 1904 and 1907. Up until 1906, Professor's Duncan's life as it was evidenced to the outside world was simply that of a successful growing teacher of chemistry. But in his inner life a great purpose had been developing and finally took form in his system of industrial fellowships. He really led a dedicated life—a life dedicated to the working out and founding of a method of sympathetic cooperation between industry and learning, whereby industry, the university, the public and young men would be greatly advantaged. In 1906 Dr. Duncan was called to the University of Kansas as professor of industrial chemistry and it was then and at that time that he initiated on a small scale his new system of industrial fellowships. In 1910 he became director of the department of industrial research of the University of Pittsburgh, which department, in 1913, became the Mellon Institute. It was in the University of Pittsburgh that industrial fellowships expanded with such extraordinary rapidity to the present large institution.

As an educator in the field of science Dr. Duncan's influence was very far reaching. He had the rare faculty of imparting to his students and associates his own overflowing enthusiasm. He inspired a peculiar loyalty to the highest ideals of scientific truth. Numerous short articles from his pen, in addition to his books—written with a unique charm of expression and power of interpretation—gave a widespread interest in things scientific. His investigations and writings on the conditions of the employment of chemists by industrialists had a marked effect in bettering the status of the industrial chemist.

As to the personal influence of his life on those with whom he came in contact, I do not know how better I can express this than by appending the following tribute from one of his "boys."

Raymond F. Bacon

ROBERT KENNEDY DUNCAN, AS ONE OF HIS BOYS KNEW HIM

There are scattered over this country a fairly large number of men each of whom is glad if Robert Kennedy Duncan ever referred to him as "one of my boys." Yes, there are many of us who are better men, who see the values of this life clearer for having been one of his "boys." To some of us he was a professor of chemistry, to some he was a director of industrial research but to all of us he was a big brother, yes even a father. He was an employer of none of us in the ordinary sense of the term. Robert Kennedy Duncan was truly "a fisher of men," a witness of the light which has ever shone clearly for those who have lived the gospel of man's brotherhood.

I wish I had the pen to enable others to understand something of his leadership. None can see all the facets of a gem from one angle. Neverthless I shall attempt to speak of him, as one of his "boys" who has been privileged to know him.

I can do no better than to select a few of his own sentences about certain deeds of men which excited his own admiration. He was fond of military analogies. In a recent article on industrial research which appeared in *Harper's Magazine* he likened the modern spirit of discovery in scientific research to the spirit of the young Marco Polo.

Let us contrast synthetic rubber with synthetic indigo. The commercial synthesis of indigo was

accomplished after a Kitchener-like advance, in which each step at a time was buttressed and battlemented by coordinated facts until the summit was attained and the fortress was won. It was an irresistible march of the horse, foot and artillery of scientific endeavor. The attack upon rubber, on the other hand, recalls nothing so much as the raid of the adventurers accompanying Cortes into the wilds of Mexico. Ludicrously few in number and ill equipped save with a *dauntless spirit*, they plunged desperately into a wilderness absolutely unknown and denizened by countless thousands of a malignant and disciplined enemy; yet they conquered Mexico. The conquest of Mexico was incredible, it was *unreasonable* to the military tactician; so is the conquest of rubber incredible to the tactician of scientific research.

Allow me to quote another sentence which I think shows one of the great elements of his leadership.

Of course I have forgotten something. I have forgotten the afternoon tire in the garish light of the laboratories, the hard cot at night by the laboratory table, the broken experiments, and the heart-breaking disappointments to endeavor. But so did Marco Polo, for you will look in vain through all his glowing pages for the bitter cold of the morning camp, or the intolerable heat of the desert or of the pain of insect pests, or of his sorrow at the loss of his goods—all forgotten in the retrospect of his wonderful journey.

Valery-Radot wrote two delightful volumes giving us a picture of Louis Pasteur, yet there are two incidents which to me are most illuminating and recall Doctor Duncan. The author tells us of Pasteur's anguish on the occasion of the death of a boy from rabies. Pasteur forthwith undertook an investigation of the subject. Finally one sees this great, tender-hearted man with all the wonderful vision of his mature years brought near death's door and in one last spasm of effort crying: "We must work. We must work." And so Robert Kennedy Duncan was removed by the accident of death just as his dreams, his great constructive dreams, for the amelioration of man seemed to be in the dawn of their fulfillment. Only last December Doctor Duncan attended the Atlanta meeting of the American Association for the Advancement of Science and met Dr. Howard A. Kelly. Sixty thousand people dying of cancer in this country every year! He returned from that meeting burning with a desire to do something. The idea that radium is and undoubtedly always will be beyond the reach of thousands of these sufferers, *that* was what appealed to him. Couldn't something be done about it? He believed there could. He told his ideas to a Pittsburgh business man, who very quickly said, "It would give me real pleasure to help you tackle this thing."

Another sentence of Doctor Duncan's will always stick in my mind and I think gives us a clue to his fine spiritual nature. In discussing the synthesis of ammonia from nitrogen and hydrogen he recalls that up to 1908 the best work of Haber, Nernst and others had failed to give results of industrial promise and as Dr. Duncan said of Nernst's work:

With this final investigation, then, it was "thumbs down" for the subject; it was finished, exhausted, dead.

But Professor Haber had a feeling that the thing could be done. Doctor Duncan says:

It is to be understood that this "feeling" which possessed Haber was not the obsession of an ignorant dreamer but was actually the expression of a *faith that lay deeper than reason* on the part of one who knew, possibly better than any one else from the standpoint of reason, its folly.

The splendid qualities which he so admired in others he himself possessed. It has ever been such rare spirits which have done the impossible, have pointed the way.

THE WELLESLEY COLLEGE FIRE

The fire at Wellesley College on March 17, which totally destroyed College Hall, the oldest and largest buiding, has brought great loss to the college and has greatly disabled four science departments.

College Hall, which originally contained the whole college community, at the time of the fire was a dormitory for two hundred and fifteen students, and also held the offices of the administration, the lecture rooms for the greater part of the college, and the laboratories of the departments of geology, physics,

psychology and zoology. The entire equipment and the collections of each of these four sciences are destroyed, and the department libraries of geology, physics and zoology. As a consequence, these departments are seriously crippled and are in great need of assistance.

The collections of the geology department were very valuable and some were very rare mineral specimens. Recently many new cases had been acquired and space for exhibition. The lantern of this department was the only piece of apparatus that survived the fire, but the thousands of lantern slides were destroyed.

The more important losses to physics are lantern slides, collection of crystals, a unique collection of Nicol prisms, and complete files of the important scientific journals, some dating back to 1800.

Besides the actual equipment, the most serious loss to the psychology department is the destruction of its records of experiments, memory and intelligence tests on normal and abnormal subjects, the results of several years of work.

The zoology museum was far richer than was generally known. It was inadequately housed and crowded, and its specimens were never displayed to advantage. The collections represented the results of many years of labor and of careful selection, and were essentially study collections, planned for special courses, and constantly in use by different groups of students. The losses which will be felt most keenly by the individual courses are the North American birds and insects, the general invertebrate collections, recently enriched by material from the zoological station at Naples, the mounted and disarticulated skeletons, the histology and embryology slides, and the physiology apparatus.

The personal losses of the teaching staff are very great. In the zoology and psychology departments alone, original work, drawings, notes, collections, microscopes and apparatus, books and reprints, all are gone.

Aid has come already in generous measure to the four stricken departments from many colleges and museums near Boston, from Clark University, Mt. Holyoke College, the University of Pennsylvania, Vassar College, and from former students and friends of Wellesley; and material has been lent and given that will enable the scientific courses to reopen with the rest of the college on April 7, in the laboratories of the departments of astronomy, botany, chemistry and hygiene, all of which are in separate buildings and are therefore untouched by this disaster.

Our future needs are very great, buildings, equipment, material for work, museum specimens, books. May the realization of these needs bring yet more help to our support.

Caroline Burling Thompson
Wellesley College

THE PRESIDENCY OF THE UNIVERSITY OF IOWA

The president of the University of Iowa has, under the date of March 20, 1914, addressed to the Iowa State Board of Education, the following letter:

By this letter I submit to you my resignation as president of the State University of Iowa, to take effect at your earliest convenience. Some explanation of this action is due to you and to those interested in the welfare of the university. Such explanation follows:

At the meeting of your board held at Cedar Falls, March 11, you considered in executive session a number of administrative matters concerning the university. Among other things at that time you dismissed a professor of the university without a hearing and without the knowledge or advice of the chief executive of the institution. Whether or not the facts, if you have them, warranted the professor's dismissal is not now the issue to which I call your attention; and I pass over for the moment the obvious fact that the professor himself had a right to be heard. I can not avoid the inference that your action is deliberately intended to express lack of confidence in the administration of the university.

Before I came to the university in 1911 I asked you in writing to consider thoroughly the step you proposed; it was for you to decide whether or not I was the man for the place and I called your attention to this fact. As part of the terms on which I finally accepted the position you agreed in writing that all recommendations for appoint-

ment and for dismissal in the university should come through my office to your board. This is the procedure in any well-governed university. At that time, also, I asked explicitly that if at any time you should feel that you would be more comfortable with another man in my position, you express to me frankly that feeling; and I stated that I would, then, with good will, promptly retire. To this also you agreed.

I can not but regret that when the time came to act under this agreement, you did not do so, frankly and honorably. You had only to ask for my resignation to receive it at once. The course you adopted to accomplish the same object is unworthy of yourselves, unjust to me, and involves a still more serious injustice to another man whose case should have been considered on its merits after proper hearing and investigation, and not entirely subordinated, as I believe it was, to the evident desire to raise, quite needlessly, a personal issue between your board and myself.

It is not my purpose to dwell on this point, however. Interpreting your action as I have no doubt it was intended, and conforming on my own part to the understanding on which I came here, I willingly withdraw from a position which I accepted only at your earnest solicitation and which I have no desire to retain unless I can demand and receive your entire support. I do this with the less regret because as I recall the issues which have arisen between us and which have led to your present attitude, I am as firmly as ever convinced that the ideals and policies which I have held for the university during the past two and one half years have been right and educationally sound; that no single instance of personal politics or self-seeking on my own part has contributed to our differences; and that if you had chosen to give me a reasonable opportunity for working out these ideals and policies they would have justified themselves in ample measure by the results.

If it were possible that I have exaggerated the significance of your action in its relation to myself, my course would still be the same. No man can be held accountable for his responsibility unless his authority is respected, or for his policies unless he is given a free hand to carry them out. This principle is recognized in all well-governed colleges and universities, as it is in every well-organized business. The efficient government of this university on any other basis is impossible, and I could not be a party to so hopeless an experiment even if it were your desire that I should.

SCIENTIFIC NOTES AND NEWS

At the annual meeting of the National Academy of Sciences, to be held in Washington on April 21, 22 and 23, the William Ellery Hale Lectures will be inaugurated by two lectures on "The Constitution of Matter and the Evolution of the Elements," by Sir Ernest Rutherford, of the University of Manchester.

A special convocation held at Oxford on March 24 conferred the degree of doctor of science on Surgeon General Gorgas.

The Fothergill gold medal of the Medical Society of London for 1914 has been awarded to Dr. John George Adami, F.R.S., LL.D., Strathcona professor of pathology and bacteriology at McGill University, for his work on pathology and its application to practical medicine and surgery.

We learn from *Nature* that the council of the University of Birmingham has appointed Professor Charles Lapworth emeritus professor of geology in recognition of his services during his occupation of the chair of geology. The senate recently signalized his retirement by the presentation of an address and a gift of plate, and on March 11 another presentation was made to him by a large number of his old students.

The last number of the *Münchener medicinische Wochenschrift* is a special issue in honor of the sixtieth birthday of Professor Ehrlich, which occurred on March 14.

Dr. Lawrence Martin, of the University of Wisconsin, has been elected a corresponding member of the International Committee on Glaciers.

Mr. R. J. Pocock, of Queen's College, Oxford, has been appointed to direct the observatory of the Nizam of Hyderabad.

Professor F. Keeble, F.R.S., professor of botany, University College, Reading, has been appointed director of the Royal Horticultural Society's garden at Wisley.

Dr. John W. Colbert, Albuquerque, has been asked by the Rockefeller Foundation to assume charge of its research work in a campaign to be inaugurated for the eradication

of hookworm disease in Central and South America.

MR. H. GLAUERT, of Trinity College, and Mr. H. Jeffreys, of St. John's College, have been elected to Isaac Newton studentships in the University of Cambridge.

THE Sarah Berliner Research Fellowship has been awarded for the year 1914–15 to Miss Ethel Nicholson Browne, Ph.D. (Columbia), now instructor in biology at Dana Hall, Wellesley, Mass. Miss Browne will spend the year at the University of Würzburg and at the Zoological Station at Naples, doing research work in cytology.

THE Kansas City Section of the American Chemical Society celebrated its one hundredth meeting on March 21. This section was chartered in 1900 and has been holding alternate meetings in Lawrence, Kansas, and in Kansas City, Missouri. At this meeting Dr. Wm. McPherson, of the Ohio State University, was the guest of honor and delivered an address illustrated with lantern slides upon "European Laboratories and Chemists."

FROM May 5 to June 23 a course of eight lectures on the rate of the blood-flow in man in health and disease will be given in the physiological laboratory of London University, by Dr. G. N. Stewart, professor of experimental medicine, Western Reserve University.

IT is stated in *Nature* that the Faraday Society arranged a general discussion on optical rotatory power, to be held in the afternoon and evening of Friday, March 27, in the rooms of the Chemical Society, Burlington House, Professor H. E. Armstrong and Professor Percy F. Frankland, presiding. Papers on various aspects of the subject were to be read by Professor Hans Rupe (Baslo), Professor H. Grossmann (Berlin), Professor Leo Tschugaeff (St. Petersburg), Dr. Darmois (Paris), Dr. T. M. Lowry, Mr. T. W. Dickson, Mr. H. H. Abram, Dr. R. H. Pickard, Mr. J. Kenyon and Dr. T. S. Patterson.

DR. HARRY BURROWS, lecturer in chemistry in the Sir John Cass Technical Institute, London, died on March 15, at the age of forty-two years.

PROFESSOR JOACHIMSTHAL, director of the University Hospital at Berlin for the surgical treatment of cripples, died on February 28, aged fifty-two years.

DR. ADELBERT VON WALDENHOFEN, emeritus professor of applied physics in the Vienna Technological School, has died at the age of eighty-six years.

THE House committee has favorably reported the bill providing that the historic botanic garden, located for many years at the foot of Capitol Hill, be removed to Rock Creek park, in the far northwest section of the city. The bill also provides that the garden is to pass from the direct control of congress to that of the department of agriculture.

MR. JOHN LAMBERT CADWALADER left $195,000 to public institutions with which he was associated, and gave valuable works of art to the Metropolitan Museum, and books to the New York Public Library. The public institutions which received legacies are the New York Public Library, $100,000; the Metropolitan Museum of Art and Princeton University, $25,000 each; Harvard University Law School and the New York Zoological Society, $20,000 each, and the Alumni Association of the Harvard Law School, $5,000.

A MATHEMATICS CLUB is in process of organization at the Ohio State University. Professors and students will have an equal share in discussing mathematical literature and some of the newer developments in the science. At the first meeting of the club, Professor R. D. Bohannan, head of the department of mathematics, will speak on the spirit of the old mathematics as related to the new, showing the quality of research, and of critical investigation which has taken the place of former unthinking respect for authority.

THROUGH the generosity of M. Spendiaroff of St. Petersburg, the International Geological Congress presents at each session a prize amounting to about 450 roubles for the best

work in some specified field of geology. The next prize will be awarded at the session in Belgium in 1917 for the best work in petrography giving new light on the general problems of the science. Two copies, at least, of any work presented for the competition must be sent to the general secretary of the last congress, R. W. Brock, deputy minister of mines, Ottawa, Canada, at least one year before the next session.

The Christiania correspondent of the London *Times* states that according to interviews in the Norwegian papers, it looks doubtful whether Captain Amundsen's expedition can start in 1914. The *Fram* appears to be delayed and must be at San Francisco at latest at the beginning of July. If delayed Captain Amundsen will use the time in order to practise his aviators and scientific staff. The *Fram* will take three aeroplanes. The German Antarctic explorer Captain Filchner has been engaged to act as observer and photographer. Dr. Nansen will next summer undertake an oceanographic expedition with the Azores as a central point.

A joint meeting of the Association of American Geographers and the American Geographical Society is being held on Friday and Saturday, April 3 and 4. The program is as follows:

THE EVENING LECTURE (ENGINEER'S HALL)

L. A. Bauer: "The General Magnetic Survey of the Earth."

FRIDAY MORNING SESSION (AMERICAN GEOGRAPHICAL SOCIETY'S BUILDING)

W. H. Hobbs: "Land Sculpturing in Arid Lands with Observations from Northeastern Africa."

FRIDAY AFTERNOON SESSION (AMERICAN GEOGRAPHICAL SOCIETY'S BUILDING)

T. Wayland Vaughan: "The Platforms of Barrier Coral Reefs."

D. W. Johnson: "Botanical Phenomena and the Problem of Coastal Subsidence."

E. W. Shaw: "Characteristics of the Mississippi Delta in the Light of Comparative Studies of Some Old-World Deltas."

Oliver L. Fassig: "The Period of Safe Plant Growth in Maryland and Delaware."

SATURDAY MORNING SESSION (AMERICAN GEOGRAPHICAL BUILDING)

Frederick J. Turner: "Geographic Influences in American Political History."

J. Russell Smith: "The Tree as a Factor in Man's Adjustment to Hilly and Rocky Land."

W. W. Atwood: "Over the San Juan Mountains to the Ancient Cliff Dwellings of the Mesa Verde."

Collier Cobb: "The Forest of Sunburst: A Study in Anthropo-geography."

Spruce, abundant in the New England and Lake States and in Canada, has heretofore been the standard wood for making news print paper and as long as there was a supply sufficient to meet the needs of the paper industry there was no reason to seek substitutes. But heavy inroads have been made on the spruce forests of the western part of the United States in this day of great circulations and large editions, especially of Sunday papers with their many parts. On a rough estimate, a newspaper with an average circulation of sixty thousand copies and an average edition of twenty pages, uses each day the product of about four acres of forest. When this figure is multiplied by the great number of newspapers published in the United States, many of them with much larger editions, and when this is further multiplied by 365, because many papers are issued every day of the year, it can be seen that the drain upon the forests is enormous. Foresters say that even under the most approved methods known to their profession, it could scarcely be expected that spruce would be able to hold its own, but would need supplementing by other material. It is but natural, therefore, that paper manufacturers are looking for new sources of supply which will furnish an abundance of wood pulp, at a price which will not be prohibitive. Poplar and a few other woods are used, but they do not go very far. In the national forests there are many woods considered inferior by lumbermen. Yet they are available for purchase at low rates and many of the timber stands are readily accessible. The forest service, in its desire to utilize to the best advantage all of the resources of the federal timber holdings,

has been seeking proper uses for these trees and has experimented in making pulp from them at its pulp laboratory at Wausau, Wisconsin, an auxiliary of the forest products laboratory at Madison. The Wausau laboratory is equipped with standard machinery and all experiments are carried out under conditions which duplicate commercial practise. As a final test of the value of some of these new woods under practical conditions, arrangements were made between the forest service and the *Herald* to print some part of its edition on paper made from various woods that showed promise as substitutes for spruce. These woods were ground at the Wausau laboratory; the product was then mixed with the usual proportion of chemical pulp and made into news print paper, rolls of which were sent to New York for the experimental run.

Settlers in western Kansas are cutting and marketing soap weed, or Spanish bayonet, to supply the demands of soap manufacturers, according to a report recently received from officers of the Kansas national forest. There are various plants in the southwest locally known as soap weed, called amole by the Mexicans, but the one gathered by the Kansas farmers, technically known as *Yucca bacata*, a species with exceptionally large fruits, is the most used. The soap manufacturers, however, utilize the tops or the roots. Manufacturers are paying $8 a ton for the plant at the railway stations, while the estimated cost of cutting, drying, baling and hauling ranges from $5 to $6, depending upon the distance to the railroad. Since a man can ordinarily get out a ton a day, the gathering of the soap weed affords an opportunity to secure a fair day's wages at a time when other ranch activities are not presssing. After cutting, the soap weed is allowed to dry from 60 to 90 days and then is baled up in the ordinary broom-corn baling machine. For a long time this weed has been made into a soapy decoction which the Indian and Mexican women have used, particularly for washing their hair, for which purpose it is considered especially suited, since it contains no alkali. Present-day soap manufacturers use it for toilet and wool soaps. Its qualities have been known for a long time, but the harvesting of soap weed is just now becoming commercially important. The industry is now operating on lands adjacent to the Kansas national forest and it is expected that the demand will soon spread to that forest, some portions of which bear an abundant supply of the plant. There is a plentiful supply of it throughout southern Colorado, Arizona, New Mexico and Texas. Forest officers have considered this weed a nuisance, since it is the nature of the plant to spread over extensive areas and kill off other vegetation. It is particularly a pest on stock ranges. In line with its policy of range improvement, the government is anxious to rid the forage areas of all such injurious plants, and it is the hope of the forest officers that the commercial demand for soap weed will soon reach such proportions that it will not only take an otherwise useless product, but also will eradicate it from areas which could be utilized to better advantage for the supplying of forage to cattle and sheep.

It is generally recognized that boric acid in considerable quantities is an original constituent in the waters and gases given off with volcanic emanations. In fact, the Tuscan fumaroles, in Italy, have been an important commercial source of boric acid for a long time, and in the past, possibly even to the present time, almost all the boric acid brought into the European market has been derived from this source. There is abundant evidence of the presence of boric acid in volcanic emanations in many parts of the world. On the other hand, boron is so rare a constituent of rock-forming minerals that it forms an almost inappreciably small percentage of the earth's rock mass as a whole. A short study of the borate deposits in Ventura County, Cal., supplemented by more cursory examinations of similar deposits in the vicinity of Death Valley, has been made by Hoyt S. Gale, of the United States Geological Survey, and a new theory of the origin of the deposits of colemanite, or borate of lime, in these regions has been advanced by Mr. Gale in Professional Paper 85, Part A, recently published by the Survey. While this theory has not yet been entirely proved, there is much in its favor and it affords suggestions and a working basis

for further observation. The supposition of a desiccated saline lake to explain the origin of the colemanite has little to support it beyond rather general assumptions. The character of the deposits themselves indicates rather a vein type of formation. Other salines which would naturally be expected in desiccation deposits resulting from natural saline solutions are not found in association with the colemanite. Those who have supported the desiccation theory have offered no explanation of the cause which might produce colemanite in such massive deposits as a product of water evaporation, while, on the contrary, its formation from limestone in veins by replacement of carbonic acid with boric acid is a natural hypothesis that deserves further investigation. The relations of the deposits to basalt lava flows indicate the probable origin of the boric acid at the time of the extrusion of these lavas, although it may be assumed that this acid continued to find its way into solution of the circulating ground waters long after the period of the extrusions.

UNIVERSITY AND EDUCATIONAL NEWS

Provisions for the creation of a trust fund said to be approximately $500,000 for the maintenance of male graduates of the Williamsport, Pa., high school at Cornell University are made by the will of Albert Dubois Hermance.

Mr. Edgar Palmer, a Princeton graduate of the class of 1903, has offered to build and present to Princeton University a stadium costing $300,000. Mr. Palmer is a son of the late Stephen S. Palmer, who was for many years a trustee of Princeton University and gave large sums to the university, including the Palmer Physical Laboratory.

Through the cooperation of the estate of the late Dr. C. Annette Buckel, of Oakland, a research fellowship for the study of feeble-minded children has been established at Stanford University. The department of education, under the direction of its head, Professor E. P. Cubberly, will have the appointment of the fellow, who will work in cooperation with Professor Lewis M. Terman. Dr. Buckel was an Oakland physician known for her charitable work in Oakland and for her interest in feeble-minded, backward and delinquent children. On her death her estate was left in trust to Miss Charlotte S. Playter, of Piedmont, to be used to advance the condition of backward and feeble-minded children. Miss Playter has turned the money over to Stanford. The income amounts to about $500 a year, and the board of trustees of the university have added an additional $500 to the fellowship.

Work has begun on a temporary recitation and administration building for Wellesley College. It will be a wooden structure, one story high, of the simplest possible construction. It is contracted to be finished by May 1. Classes will begin on April 7, the regular date for the opening of the spring term. There are no plans as yet to replace the geological, physical, psychological and zoological laboratories which were destroyed by the burning of College Hall.

The recent disastrous fire at Wellesley College wiped out the entire equipment of the department of physics. This department, organized in 1878, was one of the first in the country to offer laboratory practise for undergraduates and possessed much apparatus of value. Within the last few years extensive additions had rendered the equipment thoroughly modern and up to date. The library of nearly three thousand volumes contained complete files of most of the leading periodicals, English, French and German, including the *Annalen der Physik*, the *Philosophical Magazine*, and the *Philosophical Transactions* since 1800. The loss is total.

Yale University and the University of California will exchange professors next year. Professor John Wurts, of the Yale Law School, will lecture at California, and Professor G. H. Boke, of the School of Jurisprudence at California, will lecture at Yale.

Dr. Thomas H. Macbride, professor of botany, has been appointed acting president of the State University of Iowa.

Dr. Nathaniel E. Loomis, assistant professor of chemistry at Bowdoin College, has

accepted a professorship of physical chemistry at Purdue University.

DR. L. D. BRISTOL, now of Syracuse Medical School, has been appointed to succeed Dr. G. F. Ruediger as director of the public health laboratory of the University of North Dakota. Dr. R. T. Young has been appointed professor of zoology and succeeds Dean M. A. Brannon as director of the University Biological station at Devil's Lake.

DR. PRAFULLA CHANDRA RÂY has been appointed to the Sir Taraknath Palit professorship of chemistry, and Mr. C. V. Raman to the Sir Taraknath Palit professorship of physics in the Presidency College, Calcutta.

DISCUSSION AND CORRESPONDENCE

DADOURIAN'S ANALYTICAL MECHANICS AND THE PRINCIPLES OF DYNAMICS

PROFESSOR E. W. RETTGER'S review of my "Analytical Mechanics," which appeared in number 995 issue of SCIENCE, gives a wrong impression of my treatment of the principles of dynamics.

The reviewer's criticisms are directed, mainly, against my claim of having based the science of mechanics upon a single dynamical principle. Starting from certain premises, which can not stand close examination, Professor Rettger arrives at the conclusion

> He makes more assumptions than are usually made in elementary text-books of mechanics.

Let us consider the main points of his criticisms in detail and see whether the foregoing statement is based upon facts.

> On page 16, he introduces the conception of "force" as an "action" and without hesitation applies vector addition to a system of forces. What is he doing here, but assuming the "parallelogram of forces" in its most general form?

It is intimated here that the "parallelogram of forces" is a dynamical law which I have "assumed" without formally introducing it as a new law. It is a fact that I have applied vector addition to forces "without hesitation," but I have shown as little hesitation in treating velocities, accelerations, torques, linear momenta and angular momenta as vectors. Why did not Professor Rettger accuse me of having assumed the "parallelograms" of these magnitudes? Is the "parallelogram of forces" more of a dynamical law than the "parallelogram" of torques, for instance? The "parallelogram" law applies to any vector and is not at all a characteristic of forces, therefore it is not a dynamical law. It does not even deserve being called a "law" when applied to a special type of vectors. In its most general form the "parallelogram law" is the principle of the independence of mutually perpendicular directions in space, a purely geometrical principle. A special case of it is known to students of plane trigonometry as the "law of cosines." In the first chapter of my book this principle is given in its most general form as well as in its several special forms, and is applied to vector magnitudes of different types. After devoting an entire chapter to vector addition and after defining force as a vector, to introduce the "paralellogram of forces" as a new law, as Professor Rettger would have it, could serve only to show that the man who did it could not have a clear conception of the meanings of the terms he was using.

> On page 102 he assumes that a force is proportional to the acceleration produced. This assumes Newton's second law.

This statement is not quite right. The relation between force and acceleration, which I have called *force-equation,* is derived on page 106 from the fundamental principle which I have postulated. In this derivation I have made use of the definition of *kinetic reaction,* which is stated and illustrated on pages 102 to 105, but this is not equivalent to "assuming" a new principle. Will Professor Rettger claim that to define the terms used in a principle is equivalent to introducing or "assuming" new principles? Suppose I had based my work upon the principles of the conservation of energy and of the conservation of momentum should I have no right to classify and define the different forms of energy and of momentum without being rightly accused of having introduced new principles? Will Professor Rettger consider the definitions of momentum, of potential energy, and of kinetic

energy as principles and state that mechanics can not be based upon the principles of the conservation of energy and of momentum alone?

What about the law itself? The first part of the law is clear. "To every action there is an equal and opposite reaction" is nothing but Newton's third law of motion. The word "or" leads us to think that the second part means the same thing as the first part.

Had Professor Rettger examined my book with greater care he would have noticed that I have used the term "reaction" in a slightly different sense and that with this difference the "first part" is not at all Newton's third law but has the same meaning as the "second part," and that the two "parts" are only two different forms of the statics principle. Further he would have seen that the first form is not made use of, the entire work being based upon the second form alone, and would not have charged me of having assumed Newton's third law in addition to the one I have introduced. The first form is left out entirely in the papers which I published on the subject.[1] In one of these papers I have even shown that Newton's third law is a direct consequence of the second form.

I have postulated the following principle, which I have called the *action-principle:*

The sum of all the actions to which a body or a part of a body is subject at any instant vanishes:

$$\Sigma A = 0.$$

Then I have classified and defined the different forms of action. On this principle I have based my treatment of mechanics, and claim that I have given it a degree of unity and logical continuity which is not common to treatments of elementary mechanics. This is made possible by the simplicity and flexibility of the action-principle, which is easily grasped by the beginner, yet conveys a depth of meaning and breadth of application commensurate with the knowledge and ability of the student.

[1] "On a Progressive Development of the Principles of Mechanics," *Physical Review*, May, 1913; "On a Progressive Development of Mechanics Based Upon a New Form of the Fundamental Principle of the Science," *American Journal of Science*, February, 1914.

Besides this pedagogical advantage my treatment involves a point of view which is in harmony with our present ideas of dynamical phenomena, as it is shown in my recent paper on the subject.[2]

H. M. Dadourian

Yale University

[2] *Loc. cit.*

A NEW METHOD OF COOPERATION AMONG UNIVERSITIES

In April, 1910, was formed at Kansas City, Missouri, the Missouri Valley Conference of Heads and Governing Boards of Universities. The Conference embraced, however, only the institutions up to that time belonging to the Missouri Valley Conference for athletic purposes. There have been many conferences and associations of professors of universities and presidents of universities, or both, and there have been conferences of school boards representing the public schools in various cities, but this is probably the first attempt on the part of university governing boards to accomplish a general understanding and cooperation in regard to matters affecting institutions similarly situated. The conference arose over the matter of intercollegiate football, the question so fruitful of controversy and discussion. The reason for the conference was as follows: There had been introduced into the board of regents of the University of Kansas a resolution abolishing intercollegiate football. The vote was a tie and the motion was lost. The question was brought up again and after thorough discussion it was agreed by the board of regents of the University of Kansas that it was unwise to attempt to settle that question in one university alone and that all of the universities of the then existing Missouri Valley Conference, through their heads and governing boards, should be asked to meet in a general conference at Kansas City in April, 1910. It was at the time of large and pointed discussion and criticism of intercollegiate football and after the matter had been clearly laid before the institutions most interested all of them accepted the invi-

tation and all sent delegates except the University of Iowa. The institutions represented were the University of Missouri, the University of Nebraska, Washington University, Drake University, the Iowa State College, and the University of Kansas. Of these the universities of Nebraska, Missouri and Kansas were represented by members of the board of regents or curators and the presidents of the institutions. Drake University was represented by its president, Iowa State College of Agriculture and Washington University by professors sent by the governing boards of the institutions to represent them. The meeting resulted in a general conference upon athletics as affecting institutions in the Missouri Valley and rules were passed by the Conference and afterwards reenacted by the individual boards of regents, largely affecting the status of intercollegiate football. Among these was the rule abolishing the game on Thanksgiving Day, abolishing the short-term professional coach, and requiring that all college games be played on college grounds.

The second conference was held at Des Moines, January 6, 1911, at which various questions left over from the Kansas City meeting were discussed and acted upon. At that conference the University of Iowa was also represented by its president and board of regents. Washington University was not represented. The discussion at this conference widened out to include other things than athletics. A general discussion of the fraternity question was ordered for the next meeting and committees on uniform financial accounting and uniform pedagogical accounting were authorized. It was plain from the discussions at the second conference, and indeed by formal action, that it was intended to make the conference a permanent one to take into consideration any question touching the common life of universities that might need consideration and uniform action.

The third meeting of the Conference was held in Lincoln, Nebraska, January 19, 1914. The University of Iowa had in the meantime withdrawn from the Missouri Valley Conference and the State Agricultural College of Kansas had been added. All of the institutions in the Conference were represented. Most of the attention of this conference was given up to matters other than athletic and it was more evident than before that the Conference was developing into a general conference on the welfare of the universities having so much in common. The fraternity question received much attention, as did the question of competency in teaching. It is probable that in succeeding meetings such questions as the following may be taken up and discussed, if not formally acted upon: the ethics to be observed in calling teachers from one institution to another; substantially uniform salaries for the same grade of instructors; cooperation in giving advanced and little called for courses; interchange of students and instructors; cost of education. It seems possible, therefore, that this Conference is a beginning of a new type of cooperation, having especial significance and authority because of the fact that the Conference is made up of presidents and governing boards where the primary power lies.

FRANK STRONG,
Chancellor

UNIVERSITY OF KANSAS

SCIENTIFIC BOOKS

From the Letter Files of S. W. Johnson. Edited by his daughter, ELIZABETH H. OSBORNE. Yale University Press. 1913. Pp. 292.

A notable feature of the applications of science to the arts and industries which characterized the second half of the nineteenth century was the phenomenal evolution of agencies for scientific investigation in the interest of agriculture and the rise of a system of public research institutions extending over every country of the civilized world. The life story of the subject of this biography is essentially the story of the birth of this system in the United States and its growth from a few modest analytical laboratories to an imposing group of national and state institutions actively engaged in agricultural research, in the teaching of agricultural science,

and in the dissemination of the results of investigation.

The career of Samuel W. Johnson presents few dramatic features. He lived the quiet, simple life of the student, occupying a professorial chair in a single university for forty years, yet few, if any, have exerted a more profound influence for the promotion of scientific agriculture. A man of genius as well as of thorough training, he early conceived the idea of making the conquests of science serviceable to the basal industry of the country. Even in his student days, in 1851, he published an article—"County Agricultural Institutes"—setting forth his earliest conceptions of the ideas which later assumed a more definite form. Five years later, in an address before the New York State Agricultural Society on the subject "The Relations which exist between Science and Agriculture" he said:

"I have full faith not only that science *may* accomplish much for agriculture in the way I have indicated, but that she *will* be speedily put about the work. The tendencies of our time prophesy this. The notion that there is anything essentially antagonistic between science and practise is daily meeting its refutation, both in the laboratory and in the field. I may confidently ask, where better than in our own country shall this idea find realization? Our country now has the strength of the oldest nations with all the freshness of youth. She is girding herself up to contest among the nations for the prize of science. What worthier triumph for our republic than to win for her millions the boon of a rational agriculture?"

But Professor Johnson had not only the genius to conceive this ideal and the faith to follow it throughout a long and fruitful career, but the tact and persistence necessary to bring about its institutional embodiment.

His first opportunity presented itself in connection with the introduction of commercial fertilizers into the United States. In March, 1853, he published, under the title "Superphosphate of Lime," an account of the results of analyses which he had made of two samples of artificial fertilizers offered for sale. This work was probably the first of its kind in this country and was the prototype of a vast amount of similar work during the next twenty-five years, done at first as a private undertaking and later as chemist of the Connecticut State Agricultural Society and of the Connecticut State Board of Agriculture. "It was characteristic of the man first to form and tenaciously hold the broad idea, based upon a universal and permanent need; and then, realizing an opportunity for practical work, to set about using his skill and knowledge in routine analysis performed with all possible accuracy in order that these simple analyses should be so absolutely right that they might be an unassailable foundation for the wider work to come after."

In 1853 he was appointed first assistant and in 1856, professor of analytical chemistry in the Yale Scientific School—later the Sheffield Scientific School—and with various titles remained an active member of its faculty until 1896. During all these years, with the capacity and equipment to take high rank among scientific investigators, he devoted his powers chiefly to the instruction of his students, to the preparation of those classic text-books, "How Crops Grow" and "How Crops Feed," and to the service of the farmers of his state in promoting the popular understanding of the aid which science could render to agriculture. His platform was the farmers' meeting, his means of publication chiefly the official report and the agricultural newspaper; while the humble and prosaic work of fertilizer analysis served to furnish the practical demonstration.

Not for almost a quarter of a century did he see the concrete result of his labors in the establishment in Connecticut of the first agricultural experiment station in the United States, at first as a semi-private institution and two years later as an independent state institution under his directorship. This was followed by the founding of similar stations in other states in rapid succession, culminating ten years later in the passage of the "Hatch

Act," providing national support for at least one such station in every state. At the time of his death, in 1909, there were fifty-six of these stations in the United States with an average annual income almost eleven times that of the Connecticut station at its foundation, to say nothing of the enormously increased research activities of the United States Department of Agriculture. Truly the little seed planted in 1853 had become a tree.

In the organization and development of these new institutions the standards established by Professor Johnson and the experience gained at the Connecticut station were material factors in bringing about the success which was so soon attained. At the outset, the American stations were of necessity largely occupied with the analysis and valuation of fertilizers. From the very start, however, original research formed a part of the program of the Connecticut station, while the increase of the state appropriation in 1882 and the assignment to the station in 1887 of part of the Hatch Fund, enabled investigation to be extended to wider fields. Throughout, the work of this station, both under Professor Johnson's administration and that of his successor, has been characterized by the same sane method, the same absence of sensationalism and the same confidence in the power of good works which characterized the fertilizer analyses of the early fifties.

In 1896, Professor Johnson became professor emeritus, and in 1900 resigned the office of director of the experiment station, occupying for a year longer the position of advising chemist which was created for him. He passed peacefully away July 21, 1909, having retained to the last his keen interest in the progress of science and in the problems presented in the development of modern chemistry.

Such was, in barest outline, the active life of an unusually gifted man who had a high conception of the obligations of the scientist to the public. No brief review can do justice to the delightful personality of the man as those knew it who were closely associated with him, and which pervades the book like an aroma, revealing itself especially in the judiciously chosen extracts from his correspondence which constitute the major portion of the volume. His biographer has done her work, not only with filial piety but with notable discrimination and restraint and with marked literary ability. In these days of intense emphasis upon the practical, no more inspiring or elevating volume can be recommended to the student of agriculture who is looking forward to a career as teacher or investigator than this record of a life which attained success in the best sense through the unselfish consecration to the public service of the rigid training and high ideals of the genuine man of science.

H. P. ARMSBY

STATE COLLEGE, PA.

Researches on Irritability of Plants. By J. C. BOSE. London and New York, Longmans, Green and Co. 1913. Cloth, 15 x 23 cm. Pages xxiv + 376; 190 illustrations, largely graphs. Price $2.50.

Physiologists who are familiar with the earlier electrophysiological researches of Bose will be interested in his recent volume on certain kinds of plant responses, which recounts the results of an application of his very ingenious methods to new kinds of problems. Research workers will find this book replete with novel ideas and novel ways of attaining quantitatively comparable measures of plant irritability. The author is not primarily dealing with the fundamental problems of protoplasmic phenomena; his work may be said to concern itself, rather, with the physics of the plant as a whole, or with that of its organs, than with the component cell happenings to which recent physiological inquiry seeks to reduce these aggregates. It is somewhat remarkable that animal physiology, on the one hand, has attained a high state of development along the lines here dealt with (with its studies of the superficial phenomena of muscle contraction, blood pressure, the electrophysiology of muscle and nerve, etc.), and that the findings of this sort of study form a very

considerable basis for the more fundamental researches that prevail at the present time, while plant physiology, on the other hand, has come to the study of cell phenomena largely without passing through this stage. Electrophysiology plays but a very subordinate rôle in plant physiological texts, and refined quantitative studies of the grosser movements of the plant have never had great vogue. It is in just this general field that Bose's writings lie, and his results, while not calculated now to arouse great interest *per se*, must be taken into serious account and will doubtless throw valuable indirect light upon the more fundamental lines of study now mainly attracting attention.

The author makes, at the very beginning of the book before us, a suggestion which has great possibilities in physiological research. "Is there any means by which we might find out whether a given influence has contributed to the plant's well-being or the reverse, whether it has left it more or less excitable," etc.? "The relation between the stimulus and the response would thus form a gauge of the physiological condition of the organism" (pages 1 and 2). In physiological terms, the *tone* of the organism as a whole is here in question, and the quantitative relations between stimuli and response are to be drawn upon as measurements of tone. Now, it is just this matter of the physiological condition of organisms for the estimation of which we most require objective methods; it has been the practise of students of plant physiology to define their organisms in the terms of the older descriptive work, assuming, for example, that a number of given plants are the same thing physiologically because they exhibit the same superficial shapes, sizes, etc., to the taxonomist. Two workers may employ the same species or variety in the taxonomic sense, but their organisms may be very different physiologically and they may disagree entirely on the sort of response attained with a given stimulus or set of environmental conditions. If some of the dimensions or characteristics of the internal condition of the organism used in an experiment could be measured and stated, much would be done to avoid many of the wasteful arguments which so often diminish the efficiency of physiological workers. From Bose's suggestion it appears to the reviewer that the methods of the present work may be of value in the physiological definition of our plant subjects, just as similar methods in animal physiology are proving of value to medical diagnosticians.

The subject-matter of this book defies useful treatment in a review. A few statements may, nevertheless, be made here. Most of the study has to do with the familiar paratonic movement of the leaf of Mimosa, though other organs receive attention at particular points. To obtain an automatic graph ("phytogram" or "plant script") of this response, a thread is attached to the petiole and to a light bent lever above, the latter counterbalanced and carrying a writing point which moves over a smoked surface. A glass plate, allowed to fall by clock work, furnishes the receptive part of the apparatus. To avoid too great friction it was found necessary to make the recording point vibrate in a plane at right angles to the receiving plate, and it was possible to arrange the vibrations so as to mark time. Thus a record with this "resonant recorder" appears as a line indicated only by a series of dots on the smoked surface, the distances between the dots indicating small units of time. The apparatus is so ingenious and delicately efficient as to excite wonder and admiration in and for itself. Stimuli of several kinds are employed, applied to the leaf in various ways. The most frequently used are thermal (obtained electrically, so as to be quantitatively controlled) and electric. The graphs show a short latent period, a period elapsing between beginning and end of the fall of the leaf ("apex time") and a long recovery period. Besides these three time periods is of course to be considered the amplitude of the movement, in characterizing the nature and intensity of the response.

Some of the topics experimentally dealt with are the following—the terms themselves show the parallelism between the plant phenomena here described and the familiar ones

called by the same names in animal physiology: additive effects; influence of load, temperature and intensity of stimulus; fatigue; staircase response (quite like that of muscle); tetanization; death spasm (it looks as though a means were here offered for determining when death of a tissue ensues); influence of gases on excitability; effect of inteneity of etimulus, of fatigue and of temperature on latent period; effect of various conditions on velocity of transmitted impulse; positive and negative galvanometric and turgidity responses (each stimulus gives rise to both, but the weaker positive—erectile—response is quickly followed and masked by the stronger negative—"contractile"—one); polar effects, etc. Polar effects are very thoroughly investigated. "With feeble current the kathode excites at make and not at break. The anode excites at neither make nor break," etc. The variation of polar reaction under tissue modification, as with age, etc., is studied, with important results. In the later chapters of the book *Biophytum* and *Desmodium gyrans* are employed in studying multiple and automatic (autonomic) responses. The pulsations of *Desmodium* leaves are thoroughly investigated.

The first two sentences of the last paragraph of Bose's book sum up the general outcome of his studies as well as can be thus briefly done: "In surveying the response of living tissues we find that there is hardly any phenomenon of irritability observed in the animal which is not also found in the plant. The various manifestations of irritability in the plant have been shown to be identical with those in the animal."

B. E. LIVINGSTON

JOHNS HOPKINS UNIVERSITY

SOCIETIES AND ACADEMIES

ANNUAL CONVENTION OF THE UTAH ACADEMY OF SCIENCES

THE seventh annual convention of the Utah Academy of Sciences was held at Salt Lake City, December 26 and 27, 1913, in the chemistry lecture room of the University of Utah.

In all, three sessions were held—the first beginning at 8 o'clock Friday evening, the second at 9:30 o'clock Saturday morning, and the closing session at 2 o'clock Saturday afternoon.

From the standpoint of business transacted, this convention of the academy will rank as one of the most important in its history. A committee was appointed to take steps toward the publication of a bi-monthly magazine under the auspices of the academy. Another committee was appointed to look after the entertainment of distinguished scientists who may be visiting in Salt Lake City, and to assist them should they desire to investigate features of the region of scientific interest in their especial lines.

Professor C. W. Porter, of the Utah Agricultural College, was elected to fellowship. Miss Florence Knox, Professor Christian D. Steiner, Professor Jakob Bolin, Professor Franklin O. Smith, Dr. Helen I. Mattill, all of the University of Utah; Dr. Fred W. Taylor and Mrs. Amelia R. Taylor, of Provo; Willard R. Harwood and N. W. Cummings, of Salt Lake City; Professor George R. Hill, Utah Agricultural College, Logan, and H. R. Hagan, Logan, were elected to membership.

The constitution was amended to provide for a permanent secretary-treasurer.

The following are the officers for the ensuing year:

President—Professor Marcus E. Jones, Salt Lake City.

First Vice-president—Dr. Harvey Fletcher, B. Y. U., Provo.

Second Vice-president—Dr. C. N. Jensen, B. Y. C., Logan.

Permanent Secretary-treasurer—A. O. Garrett, High School, Salt Lake City.

Councillors-at-large—Dr. A. A. Knowlton, U. U., Salt Lake City; Dr. Joseph Peterson, U. U., Salt Lake City, and Dr. F. L. West, U. A. C., Logan.

The following papers were read at the annual convention:

"The Question of Valency in Gaseous Ionization," by Dr. Harvey Fletcher, B. Y. U., Provo.

"Community Life among Insects" (the presidential address), by Dr. E. G. Titus, U. A. C., Logan.

"Some Metabolic Effects of Bathing in Great Salt Lake," by Dr. Helen I. and Dr. H. A. Mattill, U. U., Salt Lake City.

"Corn under Irrigation," by Dr. F. S. Harris, U. A. C., Logan.

"Practical Experiments with Root-borers," by

Professor M. Rich Porter, Weber Stake Academy, Ogden.

"Workable Phosphates of the Mississippian," by Professor William Peterson, U. A. C., Logan.

"How Far is Scientific Extension Practicable?" by Dr. E. G. Peterson, U. A. C., Logan.

"Some Features of the Recent International Congress of Geologists," by W. D. Neal, Salt Lake City.

"Outline of Mining and Smelting Conditions at Santa Fe., N. M.," by B. A. Berryman, San Pedro, N. M.

"The First Law of Irrigation Practise," by Dr. John A. Widtsoe, U. A. C. (Read by title.)

"Uranium and Vanadium Deposits in Utah," by Professor Marcus E. Jones, Salt Lake City.

A. O. Garrett,
Secretary

NEW ORLEANS ACADEMY OF SCIENCE

The regular monthly meeting of the Academy was held in the Richardson Memorial Building, Tulane University, on Tuesday, February 17, with Dr. Isadore Dyer, president, in the chair and a large number of fellows and members present. The president appointed a committee of two to draw up suitable resolutions upon the death of Dr. Alcee Fortier, who had been a fellow of the Academy for thirty years and for some time corresponding secretary. The first paper of the evening was read by Dr. Irving Hardesty, professor of anatomy, Tulane University.

A number of objections to the Helmholtz theory of hearing were cited and attention was called to the impossibility, anatomically, of the basilar membrane serving in the manner usually assumed for it. Then the tectorial membrane was shown to be coextensively with the organ of Corti, to occupy the logical position, extending with one edge free over the peripheral surface of the neuro-epithelium and nearer the scala vestibuli, and that it is far more adapted and capable of being the chief vibratory structure in hearing, its flexibility being much greater and its proportions varying far more than those of the basilar membrane. A telephone theory of hearing was applied to the tectorial membrane and a model was shown in which the three divisions of the auditory organ were represented and in which the tectorial membrane was simulated as nearly as possible, both as to position and varying proportions. Sounds of varying vibration frequently applied to this model indicated (1) that the tectorial membrane does vibrate; (2) that sounds of low vibration frequency throw the entire membrane into vibration; (3) that sounds of high frequency throw only varying extents of the more slender, basal end of the membrane into vibration, such sound waves being so damped out before reaching the apical end of the cochlea as to be incapable of producing vibrations in the thicker, apical end of the membrane; (4) a certain small amount of resonance seems apparent in the tectorial membrane, but probably little more than is possessed by the diaphragm of the telephone.

The second paper was by Dr. R. B. Bean, also of the department of anatomy, Tulane University, on "The Cartilaginous Tip (Woolner-Darwin) and the Skin Tip of the Human Ear." The speaker explained that "Darwin's tubercle" in the adult represents the cartilaginous tip of the ear of the fetus, which turns forward during the late stages of fetal life. There is at the same time a folding over of the skin and a shrinking with the folding, which leaves lines in the skin over the upper outer part of the helix. These lines are present on all ears that have been observed so far. They converge ventrally, thus indicating where the skin tip has turned under the ventral edge of the helix. The lines are not always over "Darwin's tubercle" but are frequently superior to this cartilaginous point, which seems to indicate that the skin or cartilage has shifted in development. By means of these lines one is able to demonstrate that certain distorted ears, which look as if they had been injured by accident, are in reality normal. The majority of the ears of about 150 negroes preserved in formalin at Tulane University seem to be distorted, and until these lines were discovered they were considered abnormal, frost-bitten, scarred, or otherwise mutilated, but they appear to be normal because the lines of the skin are present in their proper position and relations. Observations upon thousands of negroes show that this condition of apparent distortion of the ear is characteristic of that people. The ear of the Negro may, therefore, be called a distorted or mutilated looking ear. It is smaller than the ear of the white people, and shows a greater extent of retrograde metamorphosis.

There was considerable discussion of both papers in which Dr. Mann, Dr. Clo, Dr. Dyer and others participated. The academy then adjourned.

R. S. Cocks,
Secretary

SCIENCE

FRIDAY, APRIL 10, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

WHAT IS INDUSTRIAL SCIENCE?[1]

INDUSTRIAL education is now the most pressing of all educational problems. It is, moreover, a wholly new problem; since the schools have never seriously tried, until very recently, to grapple with it. Up to the beginning of this twentieth century, the working hypothesis of the schools has been that the best possible education for every boy and every girl was that portion of a college education which each was able to secure. The banner of education bore the inscription: "Keep the path open for every child from the kindergarten to the university." The intention of this motto was good, in that it was supposed to express the idea of equal opportunity for all; but it was interpreted by schoolmen to mean that the college course was infallibly the best possible course for everybody; and that, therefore, the elementary schools and the high schools were doing their work most efficiently if those who survived their ordeal could successfully get by the guards at the gates of the colleges.

The rapid development of educational insight in the past decade has shown the fallacy of assuming that the same opportunity for all was synonymous with equal opportunity for all. The desire to discover what equal opportunity for all might mean has led to much careful study of the individual differences and of the individual needs of pupils, and also to some careful analyses of the foundations of school philosophy. These studies have shown school-

[1] Presented at the meeting of the Central Association of Science and Mathematics Teachers at Des Moines, November 29, 1913.

men that, turn and twist as they may, they are always face to face with three mighty facts. These are: (1) That the present age is an age of machines, with a new set of ideals of its own; (2) That the schools are still too much under the influence of the ideals of a grammatical, machineless age which is now rapidly passing away; and (3) That not only industry, but also the public at large, is demanding a new type of schools whose graduates shall feel at home in and be able to cope successfully with this modern world of machines.

Now facts are facts, whether we like them or not; and it is a hopeful sign of growth that schoolmen are no longer trying to obscure these three great facts by devout longings for the will-o'-the-wisp of culture for its own sake. We schoolmen have reached the point where we are seriously trying to harmonize these relatively new facts with the rest of our knowledge. Such, at least, is my attitude in trying to define what, in the presence of these facts, science might do to help the schools to usher in a new era of real industrial education.

That we are all trying to find out what industrial science may mean is proof that we are all pretty well agreed that the work now done under the name of science in most schools can not fairly be called industrial science. Whether that work may justly be called science or not is another question, and one about which there have been and still are perfectly honest differences of opinion. But this is not the topic under discussion. The problem before us is: What is industrial science? and I assume that all are ready to agree that few, if any, have yet defined it in action; *i. e.*, that few, if any, of the present school courses in science can be classed under that head. For the sake of definiteness, this problem will first be discussed for the special case of physics. The conclusions reached are equally valid for the other sciences.

Current courses in physics do not meet the demand for industrial physics because the leading ideas on which most of the elementary work in physics is based are fundamentally different from those required by industrial physics. Current courses in elementary physics have been planned by students of advanced physics under the spell of a very one-sided appreciation of what the essential elements of physics are. For when a student undertakes to grapple with such works as Newton's "Principia," or Maxwell's "Electricity and Magnetism," he finds it no easy task merely to follow the argument and to reproduce the results. Hence he naturally acquires a great admiration for the intellectual genius of the men who created such works. He knows, moreover, that his academic success depends on his ability to reproduce these works as intellectual feats only. When he himself becomes a teacher of elementary physics, he very naturally falls into the habit of presenting physics as a series of intellectual feats—of facts and demonstrations and theories and nothing more. Hence current courses have been framed and many text-books have been written with the sole purpose of teaching the laws and principles of elementary physics as coldly intellectual propositions.

As teachers of elementary physics we have thus been filled with a zeal to impart to others the principles that have cost us so much labor. We have tried to get beginners—mere infants in physics—to repeat Newton's laws of motion with some show of intelligence as to their meaning; we have had them figure coefficients of restitution, although none of us ever met one in real life. We have even let them speculate about atomic magnets and ether and

the kinetic theory of matter, long before they have enough facts at their disposal to make these theories comprehensible. This was natural enough—did not the great artists who created the science of physics do these things? But, somehow, it did not work. It was all too unusual and too abstract and too remote from the interests of real boys and girls. It was too coldly intellectual to satisfy the demands of a world of action and emotion. It was too much like learning and trying to apply the fixed rules of grammar to be really exciting. We therefore had to give it up and try again.

In the second attempt we shifted our enthusiasm from the works of men like Galileo, Faraday and Helmholtz, to the achievements of men like Watt, Stevenson and Wilbur Wright. In other words, we seemed to be giving up trying to make scientific artists out of all of our pupils, and shifted the emphasis over to an ambition for engineers. Not that we forsook entirely the traditions of the past—far from it. We merely tried to use the inventions and achievements of engineers as a bait with which to catch the unwary on the laws and principles aforesaid. We tried to use a boy's natural enthusiasm for steam engines as a means of painlessly inoculating him with the errors of thermometers, the laws of boiling, the laws of fusion, the laws of saturated vapors, and the mechanical equivalent of heat.

This second attempt was a great advance over the first, in that it showed some recognition of the rights of the victims—it took some account of the desires and emotions of the pupils. But even this plan has not succeeded. It is at best a sorry practise to try to make any subject-matter interesting after it has been selected on grounds other than the interests of those who are to learn it. This practise has not and will not satisfy the demands of industry or teach boys and girls to cope successfully with a world of machines. If it had and would, we would not now be still seeking the meaning of industrial physics.

From the first of these experiences we have learned that an age of machines is not satisfied with a physics teaching that makes a few men competent to reproduce statements of the laws of physics as coldly intellectual propositions at college entrance examinations. From the second we are discovering that the public does not consider that it is getting its money's worth out of a physics teaching that turns out a moderate number of boys and girls with a moderate amount of information about engines, trolleys, telephones and wireless, and some painful memories of a few laws and principles as an added ornament.

Both of these attempts at teaching elementary physics in an age of machines have failed for the same reason; namely, because it is not possible to gain an understanding of this age merely by counting cogs and levers, or by measuring moments and coefficients, or by speculating about atoms and ether. We have in it all overlooked the fact that the works of the great artist creators of the science of physics and those of the great engineers of physics are not intellectual or material products plain and simple, but are the expressions of a mighty spirit worked out through keen intellects into tangible form. The great physicists are great not because they merely have more brilliant intellects than most people. There are relatively many brilliant intellects and relatively few great scientists. The great engineers too have not been great merely because they possessed great intellects. Both the great physicists and the great engineers have been great because they were inspired with the spirit of science. Keen intellects are, of course, necessary too, but they are not the

determining factor. The power in such men has been, is, and always will be found in the spirit with which they work—in their disinterested devotion to their tasks and their sublime faith in the harmony of nature and in the possibility of achieving what they have undertaken.

This is no new or startling theory. It is a very venerable fact. Yet somehow it seems to have escaped attention entirely in the organization of elementary physics courses. Since the spirit of science is the dominant factor in making a great scientist, we physics teachers have not been quite bright in thus omitting it from our courses. We have been trying to play Hamlet, but have inadvertently omitted Hamlet altogether. It is encouraging to note, however, that the importance of this omission has just begun to attract attention. Some progressive teachers include the biographies of physicists in their courses, and some progressive authors include the portraits of great physicists in their texts. If the materials of physics can not be presented in such a way as to arouse a real live scientific spirit inside a boy, it may be well to show him pictures and to tell him stories of men who had it.

Yet, after all, we physics teachers are not so very much to blame for omitting the scientific spirit from our courses. If we had been inspired with it when we were children, all would have been different. When we were young, nobody knew what it was. Great scientists just felt it and lived it, but nobody seemed to think of trying to describe it, or to define it, or to tell how it felt all welling up inside and overflowing in laws and principles. There have been many attempts from Aristotle down to the present time to define the scientific method of thinking. But it is only very recently that the effort has been seriously made to portray in words just how the scientific spirit feels when it is once safely lodged inside a man.

Now that we are beginning to know something about how it feels to have the scientific spirit inside one, the stone which the builders of elementary physics courses rejected is to become the headstone of the corner of the new industrial physics. For, though they may not know it yet, the thing that the industries need most just now is this self-same scientific spirit. The public is demanding it, employers are seeking it, trades unions are hunting it everywhere, even in socialism, and the world at large in this machine age is crying out piteously for it. If we are ever to have an industrial teaching of science, it will be of a sort that succeeds in developing the scientific spirit inside people. It will be a kind of teaching that does not emphasize the loading of the intellect with facts, principles and theories; but rather one that sees to it that at all costs the hearts of the pupils are filled with the scientific spirit. Hence if we would go forward with the development of industrial physics, we must first recognize what is the essential thing in the scientific spirit.

The essence of the scientific spirit is not, as has been generally supposed, a method of thinking. It is not the intellectual process that has been divided into the steps called observation, induction, hypothesis, verification. This process, if it signifies anything real, is at best but one of the modes in which the presence of the scientific spirit inside is made manifest. Many of us have consciously tried, and as consciously failed, to impose this order of thought on our pupils with the idea that we were thereby serving science. We have failed because the essence of the spirit we want is not of this sort.

The essence of the scientific spirit is an emotional state, an attitude toward life and

nature, a great instinctive and intuitive faith. It is because scientists believe in their hearts that the world is a harmonious and well-coordinated organism, and that it is possible for them to find harmony and coordination, if only they work hard enough and honestly enough and patiently enough, that they achieve their truly great results. It is this faith inside them that inspires them to toil on year after year on one problem. How else could Darwin have toiled on all those years to find coordination in one direction? Was it because he wanted to make himself unpopular with the theologians and to set their tongues to wagging against him all over Christendom? Or was it because the problem interested him, and because he knew in his heart that there must be such a thing as law and order among living organisms, and that such order could be found if only he worked patiently enough and honestly enough?

The same is true of inventors and engineers. Their greatness does not depend primarily upon the fact that they have keen intellects and use scientific methods of thinking. When Wm. McAdoo conceived the idea of the Hudson River tunnels, it was not the idea alone that made him achieve them. Many others had thought of tunnels under rivers before. It was rather his belief that the thing was worth while, backed by an indomitable faith in things and in men. He knew in his soul that the people needed this and that it could be done, and he knew it with such energy that he succeeded in accomplishing it. Brains were useful and even necessary too; but the real source of his success was the will to do, and this in turn comes from a profound and indomitable faith that there is law and order in the world and that therefore it can be done.

Look where you will at physics in real life, and you will always find that the heart and soul of it is an unquestioned faith in things and in the harmony and relatedness of things, united with an unquestioned faith that it is possible for any man to find harmony and relatedness among things if he devotes himself whole-heartedly to the task.

Look where you will at physics-teaching in the schools, and what do you find? Hundreds of teachers—all of us—bustling around with definitions of the unit in physics bound over our eyes. Open any one of these definitions, and what do we find? That the teachers must see to it that each pupil does not less than 30 experiments described in the following list; that teachers should use algebra and geometry when they find it convenient; that teachers should not confuse the pupils with too elaborate apparatus nor allow them to obscure their results under unintelligible units. Hereunto is appended a mighty syllabus, which has cost some committee many hours of hard labor, and which contains the united wisdom of the committee as to what must be included in the course. Such a syllabus of topics we all carry with us always lest we forget some weighty or massive point, and so leave a vacant space in the logical system with which we are trying to adorn our pupils.

So long as we teachers insist on keeping such definitions and such syllabi before our eyes, so long will a real industrial physics be impossible. The syllabus of industrial physics contains only one topic, and that is a topic that no teacher or committee of teachers has ever yet thought of putting in any syllabus yet made. This may seem strange to us at present, with our eyes all blindfolded in our present stately game of blind-man's bluff; but twenty years from now, when our eyes have been opened and industrial physics is in full swing everywhere, the tables will be

turned. We will then wonder how we ever could have been such silly boys as to have been blinded by syllabi that utterly fail to mention the one and only thing that gives science its final and distinctive claim to a leading place in any system of truly democratic education.

The syllabus of industrial physics will be brief and full of meaning. It will read somewhat like this: Topics I–XC, Paragraphs A–Z. The Scientific Spirit. This includes: (1) a militant faith in things, in the harmony of things, and in what men can do with things; (2) an eagerness to seek facts and to treat facts as facts; (3) an imagination that is able to see old facts in new perspectives.

This syllabus contains no topics like those in which the current syllabi abound, because there are plenty of books in which all these topics are fully treated. If a man has the scientific spirit, he will look them up in books whenever he needs any of them so that they come to have meaning for him in the joyous work of living. This is no more than he now has to do if he wants really to use those now covered in physics courses in any important undertaking.

This syllabus contains no required list of experiments; because, to a man with the scientific spirit, all life is one magnificent series of experiments.

This syllabus, finally, contains no petty directions to the teacher; because the result demanded is emotional in nature and depends on the tact, the intuition and the scientific spirit of the teacher. Fortunately no one has yet attempted to formulate set rules for the development and administration of the scientific spirit, so there is hope for success here by a real live teacher.

Like all truly great things, this syllabus is beautiful because of its simplicity. It is, moreover, the same for all the sciences. Committees will not have to waste much valuable talent haggling over its details, but can spend the time thus liberated in learning to apply it. Hence, when it has once been adopted, progress in industrial science will be rapid.

There are a number of reasons why it is certain that this simple syllabus is the one that industrial science is going to adopt. In the first place, this is the syllabus that the colleges now want to have adopted. It is the syllabus that the universities use in their advanced work, and the one that the colleges would like to adopt for their own use if only the secondary schools would be good enough to forget the old syllabi that the colleges made. Although the colleges really want to have this new syllabus adopted, none have yet had the bravery to say so openly; because the new syllabus demands a result which can not be examined in two hours by the college entrance examination board. Even the colleges that lie outside the influence of this board, and that admit wholly on certificate, still like to hold on to the possibility of giving entrance examinations if they ever should want to do so. Standards of something-or-other seem somehow to be maintained by this process.

In the second place, the elementary schools are demanding the adoption of this syllabus of industrial physics. In fact, the elementary schools are seriously trying, with their nature study and their general science, to put it into effect themselves. They know that most children come to the first grade with marked symptoms of scientific spirit cropping out all over them, and they know that these same children leave the eighth grade with their scientific spirit a sad caricature of its original self. But the elementary school can not both make its own teachers and teach the children. The teachers must come from above; and hence progress will be slow until the

high schools, the normal schools and the colleges take hold and help too. That it is decidedly to their own selfish interest to do this is perfectly obvious. If the scientific spirit of the children could be preserved instead of deadened in the schools, the work of the higher institutions would change utterly—would become veritably inspired.

But finally, and most important, the syllabus for industrial science is the one just outlined because it is the one that commerce and industry and the public and the world at large are demanding of the science teachers. This is evident because the history of the development of our civilization shows that, since the destruction of Rome, progress has consisted in a continual series of triumphs by men who believed in things over men who believed in words. Magellan believed in things; and when his fleet had sailed off the west end of the world and sailed safely back on to the east end of it without being seriously inconvenienced by the feat, the words of those who liked to prattle about flat worlds became rather insipid. Watt, and Stevenson and Fulton believed in things so vigorously that they actually succeeded in reducing this earth to about one-eighth of its former size, and in expanding the strength of men to the nth power. No amount of talking could ever have accomplished that. The telegraph, the telephone and wireless have compressed the world to still smaller dimensions. The Hanseatic League, the craft guilds, the so-called Renaissance, the development of a merchant marine, the expansion of industry and commerce, are all the work of men who had faith in things. The effects of this work are not material only; for the tangible results of it have been silently working on men's ideals all the time and as silently reconstructing them. It has done more to make men comprehend the idea of universal brotherhood than all the words that were ever uttered about it.

All this is work of the scientific spirit as here defined. It is forcing on us new conceptions of goodness and justice, new ideals of success and failure. It is even developing in us a new faith; for the scientific faith in things and in the possibility of finding among things a harmony which includes them all is now expanding into a faith in men and in the possibility of finding among men a justice which includes them all. This fact appears explicitly in the work of Taylor and others on scientific management, and implicitly in the change that is rapidly coming over business methods everywhere.

The prophets of our time are telling us that a few years ago the general idea underlying business and industrial transactions was "get all you can out of everybody and give as little as you can in return." Business is business was the motto. While this idea still pervades much business, the most successful firms at present are those which have felt the inspiration of this expanded spirit of science and which therefore realize that this idea is, in the light of the facts, a false one. To be permanently successful in business or industry, one must deal with the same people for long periods of time; and this is possible only when all parties to the transaction are satisfied. All parties will be satisfied only when there is mutual confidence in one another and a recognition that all have been treated fairly and justly. This means that business and industry are coming more and more to be guided by men who have a faith in men as well as in things, and who believe that there must be a social and economic order which will give a justice that is best for all and which can be found if men seek it long enough and honestly enough. Business men are coming to this faith, not be-

cause it is a pious moral thing to do, but because it produces tangible results. If workmen feel that they have been treated justly, they are happy and take interest in their work; and happy and interested workmen are more efficient than unhappy and rebellious ones. It pays to treat men justly and to seek a justice that is best for all. The scientific spirit always pays when intelligently applied.

Now it is because the people sense the fact that this expanded and more mature scientific spirit is coming to the front in business and in industry, and because they see that it pays, that the public is demanding the development of scientific spirit in the schools. The situation is full of meaning for teachers of science. In the first place, it is evident that the public has come to believe in the scientific spirit. The public has tasted of this spirit and is bound to have more. If the present schools will not supply it, the public will either make it themselves in business, or found other schools that can make it. Are not the business men of Illinois even now trying to have a second set of schools established in the hope of securing just this? Present schools are beginning to have competition in this development of scientific spirit. Syllabi of facts are no longer the sacred symbols of the faith—it is spreading of itself wherever men are honestly trying to cooperate in work that is significant to them. If we science teachers do not wake up to this situation, our jobs will soon be gone, and the schools may be reduced to the function of teaching the three R's.

Besides, we science teachers are really rather dull when we allow our individualities to be submerged by syllabi and definitions of units. Why do we insist on hiding our light under a bushel of facts and principles of elementary science, all of which can be bought for a dollar and a quarter from any one of a dozen enterprising publishers? And why do we all suppress our personal enthusiasms and all try to make ourselves up to look each as much like the other as possible, and all as much as possible like forty experiments from the following list? That we do so is the more surprising when we realize that we are thereby not merely faithless to our trust as guardians of the scientific spirit, but that we are in addition actually making for ourselves a whole lot of tedious and unnecessary work. It is a great deal easier to develop scientific spirit in lively youngsters than it is to suppress their liveliness with an inherently barren and uninteresting syllabus. It is vastly more fun for the teacher too, if he will just be himself and let his enthusiasm spread through the class. He will not have to be a slave to examination papers and notebooks if he can get the class to working on problems that are really significant and worth while in their eyes. When he sees a class so absorbed in the things they are doing that they forget when it is time to go to the foot-ball game, he can be perfectly sure that they have acquired the scientific spirit and hence need no further examinations. They will then have mastered the syllabus of industrial science.

That we are rapidly drifting toward such work is shown by the success of those experiments in which boys spend half their time in school and the other half in some shop. The shop lends reality to the school work and makes it seem worth while. But the schools might make their work seem worth while without the shop, if only they would adopt the syllabus of industrial science in place of the syllabi that have been standardized by the authority of official utterance of the committee of ten. Those syllabi belong to the age that trusted in words; the syllabus of industrial science

belongs to the age of machines, which is founded on a faith in men and in things.

If I were to stop here, I would have defined industrial physics in its fullest sense. I would not, however, have given any specific directions as to how to go to work to frame a real course in industrial physics. What subject-matter shall be used? What topics? These are very practical and very pressing questions in the every-day routine of schools. To such questions as these there is but one answer; namely, use any subject matter in which you can get your pupils so absorbed that they forget everything else but the thing they are doing. Use the subject-matter of the old syllabus, if you want to, and if you think that you have the genius so to clothe it with significance that all the students will become absorbed in it. It is not absolutely impossible to do this. Experience seems to indicate, however, that teachers will have more success if they change the type of problem from the kind in which only physicists are naturally interested to a kind that has more local color and that the rest of the world find essential. For example, instead of trying to interest the pupils in the errors of thermometer scales, the specific heat of aluminum, or the coefficients of expansion of iron and brass, why not set the class on the problem of finding the best grade of coal in town? Or perhaps they would find the relative efficiencies of various types of cooking utensils and gas stoves a fruitful topic? If such topics as these seem to lack the appeal to the creative instincts, the design and construction of an electric lighting system for a house or a miniature town might prove more stimulating. If this still seems to lack the vitality of the real thing, organize the class into a scientific information bureau and invite the citizens to send in their real problems to the class for solution. A plan of this kind, in operation in Springfield, Mass., was described in the November number of *School Science and Mathematics*. It suggests rich possibilities.

The best example of industrial science that I know of is the work of the corn clubs and the canning clubs of the south. This work was started and is being guided by the General Education Board, and is wholly independent of all school systems. It has, therefore, not been standardized to death. Corn clubs are for the boys, and their purpose is to see which boy can raise the greatest number of bushels of corn per acre. The boy who, by his careful attention to this work, actually produced 210 bushels from his acre, as well as all the other boys involved, incidentally have been raising other things than corn. They are beginning to have faith in things and in what they can do with things. They are beginning to appreciate the value of facts as facts. Their imaginations are at work, figuring, perhaps, how they may slip the corn belt down south and leave Illinois, with its measly 34 bushels per acre up in the cold. They are contributing to the world's work. They are having real industrial science.

In like manner, the canning clubs are for the girls. They meet at the houses of the members and can tomatoes which they have themselves raised. They work with enthusiasm, and have so far perfected their product that, in open market, they get two cents a can more for it than is paid for factory brands. Unlike factory hands, they are happy in their work. They are learning that the scientific spirit pays. Like the boys, the girls have been raising other things as well as tomatoes. They too are beginning to master the syllabus of industrial science, and to have faith in things and in facts, and to see the world in a new perspective. If this sort of work continues and develops farther, who knows but that

the north, with its highly standardized school system, may have to import its scientific spirit from the corn and canning clubs of the south? If we science teachers wish to avert such a humiliating catastrophe, there is but one thing to do; go to work and develop an equally efficient industrial science in the schools.

This is the only thing that will statisfy the present demand of the public and convert the schools of a machineless age into educational institutions that will turn out pupils competent to understand and to cope with this age of machines. For machines are one of the products of science; and if they have caused misery and slavery among workmen and have reduced human beings to machines, it is because they have been owned and manipulated by men who did not possess the scientific spirit. Machines are bound to master and to control men who try to manage them with words or with the ideals of the past machineless age. Only men with the true scientific spirit are able to understand the real meaning of machines and to use their power for the uplift of humanity. Only men with the sacred faith can ever hope to master and to control them permanently.

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THE FUNCTIONS OF AN ENVIRONMENT[1]

In its nature the present paper falls within the field of abstract physical science, and it can, I fear, interest biologists only through its conclusions. But there is reason to believe that by means of these conclusions a trustworthy foundation for the systematic study of the environment may be established.

The result of my recent inquiry into the relation between the organism and the environment[2] has been, as I believe, proof that a hitherto unrecognized order exists among the properties of the elements. This new order is, so to speak, hidden, when one considers the properties of matter abstractly and statically. It becomes evident only when time is taken into consideration. It has a dynamical significance, and relates to evolution.[3] It is associated with the periodic system of the elements in somewhat the same way that the functional order is related to the structural order in biology. Hence it is not independent of the other order, but may be said to lie masked within it.

This is no novel experience, that the consideration of phenomena in time should lead to new points of view. In truth, it might almost have been said *a priori* that a new order must be revealed by a study of the properties of matter in relation to evolution.

This order may be described abstractly as follows:—The properties of matter are not evenly distributed among the elements, nor in such a manner as can be explained by the laws of chance, nor are they altogether distributed in the manner which the periodic system describes. If the extremes be considered, all the physical and chemical properties are distributed with the very greatest unevenness, so that the extremes are concentrated upon a few elements, notably hydrogen, oxygen and carbon. As a result of this fact there arise certain characteristics of the cosmic process which could not otherwise occur.

The characteristics which make up this unique ensemble include the greater number of characteristics and especially the most important and the most conspicuous physical and chemical properties. This order has for cosmic and organic evolution extremely important results—maximal stability of physico-chemical conditions and maximal complexity in the physico-chemical make-up of the surface of a planet; further, the possibility of maximal complexity, durability and activity of physico-chemical systems in such an environment.

All the considerations upon which these results are based are purely physico-chemical,

[1] Read before the American Society of Naturalists, December 31, 1913.

[2] "The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter," New York, The Macmillan Company, 1913.

[3] I do not, of course, refer to radioactivity, and the possible evolution of the elements.

and are quite independent of biology in any respect whatsoever. Biology is nevertheless dependent upon them, for life can manifest itself only in active physico-chemical systems. Thus a further and more interesting conclusion arises:—In fundamental characteristics, *viz.*, in the physical and chemical properties of water and carbonic acid and in various other similar respects, the actual environment is the fittest possible abode of life.

To some of my critics this statement not unnaturally seems extravagant.[4] But I hope that this may be due to my failure clearly to explain its meaning and its foundation, rather than to a real fallacy in its development. For in the first place it is to be observed that by fundamental characteristics I mean just those abstract physico-chemical properties like temperature, concentration, stability, chemical activity, etc., which can be measured. And in the second place, I mean not merely a few of such characteristics, but, so far as physical science can recognize them, all such characteristics. Now there can be no doubt that, in respect to these things, water, carbonic acid and the three elements are really unique, and nobody who has examined the evidence has thus far expressed a doubt of it. I need hardly add that I am speaking of the world as we know it and not of any hypothetical world in which matter assumes unknown forms and activities.

The difficulty, then, must lie in what appears to certain biologists, though I think not to the physicists, as an unwarranted assumption. This is that stability, wealth and variety of supply of matter and energy, and mobility thereof, and a host of other similar characteristics, must be an advantage to life in its effort to evolve, and that this is true not merely of life as we know it, but of any possible life manifesting itself in the world as we know it, in this world of our modern astronomy, physics and chemistry. Further, that the greater the magnitude of these characteristics the greater the advantage to life, and hence that, among the compounds and elements which we know, the environment made of water and carbonic acid on a planet's surface is the fittest. Of course I do not mean this planet—this earth—but any planet constituted like those of our universe; for I am dealing abstractly, not specifically, with cosmic evolution.

[4] R. S. Lillie, SCIENCE, N. S., XXXVIII., 337, September 5, 1913; J. Arthur Thomson, *Hibbert Journal*, p. 220, October, 1913.

This difficulty raises the question, which evidently can be but imperfectly answered, what are, speaking generally and abstractly, the relations between any material system and the rest of the world? This, once more, is a purely physico-chemical problem.

As a result of the thermodynamical studies of Willard Gibbs and his development of the phase rule, a large part of modern physical chemistry is concerned with the classification of systems, their activities, and the conditions of equilibrium within them. An aggregate of matter occupying a position of space is a physico-chemical system. In physical chemistry it is customary, for the sake of the simplification, to study closed systems, that is to say, systems which are not exchanging matter or energy with the outside world. But it is quite possible to proceed from these closed systems to such as are exchanging matter and energy with their environment. Now the phase rule has made possible a very complete and exhaustive classification and description of systems in a perfectly abstract way.[5] Necessarily, therefore, it has provided a complete qualitative physical and chemical analysis of the fundamental characteristics of any system.

In addition to its material and spatial characteristics a system must manifest activity. In the very simplest case it will at least exhibit that motion which we call heat. But activity also has been brought completely under the sway of physical science, for energetics deals exhaustively with all forms of physical and chemical activity.

[5] It must be pointed out that there is a certain incompleteness, which happily is of minor importance for our present purpose, in the failure to take account of such a thing as electrical potential.

It seems to be true (one may note in passing) that with the progress of science the term mechanism has come to mean merely any active system. In what follows I shall, therefore, use the word mechanism in this sense. According to this definition the mechanistic explanation of a phenomenon is simply its explanation as the activity of a system, and this is the only explanation known to physical science.

Finally, in addition to its material, spatial, and energetic characteristics a system must also be characterized as a whole and in its parts, in its form, structure, and activity by durability. The consideration as well of time as of activity permits the transition from the statical to the dynamical.

In short, form and size, physical and chemical constitution, activity and duration are the general factors to be considered in any phenomenon whatsoever. In the complete description of any mechanism all must be considered, but, for the purposes of physical science no others need be, or indeed can be, introduced.

It is accordingly possible, without any examination of the results of biology, and even in complete ignorance thereof, to investigate the fitness of the special properties of matter for any mechanism, *i. e.*, for mechanism in general.

THE SYSTEM

The fundamental characteristics of a system are the components, the phases, the concentrations, and further temperature and pressure. Hence fitness for *any* system involves the possibility of the greatest number and variety of components and phases, of the widest ranges of concentrations, temperatures and pressures. It has been shown in "The Fitness of the Environment" that the number of possible components (chemical compounds) consisting of carbon, hydrogen and oxygen is far greater than in the case of other elements; that the meteorological cycle mobilizes on land and sea far greater numbers of other elements than would be the case if water were not the active agent in the process; that an aqueous solution is capable of holding a far greater number of components in far greater concentrations than can any other; that water makes possible, through its unique thermal properties and its unique qualifications in relation to colloids, the greatest possible number and variety of phases. Moreover, many other similar facts have been established without coming upon an unfavorable instance or exception in the course of prolonged search. As for wide ranges of temperature and pressure, they may be passed by, for as a rule such conditions are not consistent with durability, hence their importance is very restricted.

ACTIVITY

Any activity is possible provided a suitable system exists and provided suitable energy is present. This fact leads us back to the conclusion that chemical transformations of hydrogen, oxygen and carbon are the very best chemical means of storing and liberating energy, and that the reactions of organic compounds permit the most delicate adjustments of such transformations. Further it has been shown that the unique thermal properties of water are most highly suited to the storing and distribution of energy, while its solvent power facilitates osmotic pressure and diffusion. It may also be mentioned as a final instance of fitness for activity, among many other examples, that the electro-chemical characteristics of water are in many ways the best possible sources of electrical activity.

DURABILITY

Durability depends upon stability of conditions and upon supplies of matter and energy to replace what is used up.

The stability of physico-chemical conditions, which is due to the presence of water and carbonic acid as primary constituents of the environment, is very great indeed, and, beyond doubt, far greater than what could exist if these substances were replaced by any others. A very large part of all the data of oceanography and meteorology do but illustrate the almost inconceivable efficiency with which water, in the main through its unique thermal properties, completely checks very wide ranges of temperature, and as a rule restricts the

range of temperature within narrow limits in the waters and throughout the earth. Even more exact is the regulation of the alkalinity of the ocean by means of carbonic acid, through its unique solubility and ionizing power. These are but two among many examples of maximal efficiency in regulation.

The renewal of matter and energy are not less highly favored. The properties of water ensure everywhere the highest availability of supplies in the greatest number and concentration. Further the three elements carry with them the possibility of maximal energy supplies. In some respects, indeed, the ubiquity and mobility of water and carbonic acid, their presence in the sea, in the lakes and streams, in the air, and in the soil, which depend upon the combined action of the unique solubility of carbonic acid, the unique vapor tension of water, and its unique surface tension, seem the most remarkable of all fitnesses.

I can not further develop these considerations here, for they are too numerous and too varied, but I have elsewhere treated them extensively.[8] In truth, all the properties of water, of carbonic acid, of the compounds of carbon, hydrogen and oxygen, of the ocean, and of the meteorological process, so far as the present state of science permits their analysis, need to be considered, for each adds to the argument. Each contributes to duration, or to activity, or to the phases, or compounds, or concentrations of possible systems. Each tends to increase rather than to restrict the possibilities of mechanism, and each is the best, or nearly the best, among all the known substances in the world. And the ensemble of these properties is perfectly and extraordinarily unique.

All of these relationships are merely physical, nothing about them is biological except their importance.

From such considerations there can be but one conclusion: the unique ensemble of properties of water, carbonic acid and the three elements constitutes among the properties of matter the fittest ensemble of characteristics for durable mechanism. No other environment, that is to say no environment other than the surface of a planet upon which water and carbonic acid are the primary constituents, could so highly favor the widest range of durability and activity in the widest range of material systems—in systems varying with respect to phases, to components, and to concentrations. This environment is indeed the *fittest*. It has a claim to the use of the superlative based upon quantitative measurement and exhaustive treatment, which is altogether lacking in the case of the fitness of the organism. For the organism, so we fondly hope, is ever becoming more fit, and the law of evolution is the survival of the fitter.

Yet it is only for mechanism in general, and not for any special form of mechanism, whether life as we know it, or a steam engine, that this environment is fittest. The ocean, for example, fits mechanism in general; also, if you will, it fits the whale and the plankton diatom, but not man or a butterfly. But, of course, as everybody has known since 1859, it is really the whale and the diatom which fit the ocean. And this leads to the true conclusion of our investigation.

Just because life must manifest itself in and through mechanism, just because, being in this world, it must inhabit a more or less durable, more or less active physico-chemical system of more or less complexity in its phases, components and concentrations, it is conditioned. The inorganic, such as it is, imposes certain conditions upon the organic. Accordingly, our conclusion is this: *The special characteristics of the inorganic are the fittest for those general characteristics of the organic which the general characteristics of the inorganic impose upon the organic.* This is the one side of reciprocal biological fitness. The other side may be similarly stated: Through adaptation the special characteristics of the organic come to fit the special characteristics of a particular environment, to fit, not any planet, but a little corner of the earth.

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[8] See "The Fitness of the Environment."

THE PITTSBURGH EXPERIMENT STATION OF THE BUREAU OF MINES

PLANS for the proposed $500,000 experiment station of the United States Bureau of

Mines to be located in Pittsburgh, Pa., have been approved by the commission appointed by congress for that purpose. The federal government now owns the property upon which will be erected a group of buildings, especially designed and adapted for the carrying on of the mine safety work and other investigations in which the Bureau of Mines is interested.

Congress a year ago, in the public buildings bill, authorized a new home for the Bureau of Mines to cost $500,000. It is now expected that congress in its present session will make a specific appropriation so that construction work may begin. It is hoped that contracts may be let by July 1. The director is hopeful that the buildings may be completed in the fall of 1915, when they will be dedicated with suitable ceremony, including a second National Mine Safety Demonstration, similar to that held at Pittsburgh in 1911.

The commission which has approved the plans consists of J. A. Holmes, D. C. Kingman, chief of engineers of the United States army and O. Wenderoth, supervising architect of the treasury. The state of Pennsylvania has appropriated $25,000 for cooperation in establishing this experiment station and has appointed a state commission consisting of James E. Roderick, chief mine inspector, Dean W. R. Crane, of the mining department, Pennsylvania State College, and W. H. Caverly. This latter commission has tentatively approved the plans.

The buildings which will constitute the experiment station of the bureau will form a part of a most remarkable and unusual group of monumental edifices devoted to educational purposes. On one side the bureau's buildings will face the great group of structures of the Carnegie School of Technology. On another side is the Carnegie Institute, in which are the art gallery, museum and library. Nearby is the imposing pile of buildings of the University of Pittsburgh. Other nearby buildings are the Memorial Hall, Pittsburgh Athletic and University Club and the Hotel Schenley. The site consists of nearly twelve acres of land, part of it on the higher level of the city streets and part of it on the level of the B. & O. Railroad, which railroad will furnish adequate facilities for passengers and freight traffic.

The group consists of three main buildings facing Forbes Street and the several street-car lines from the uptown district. The central building of the group, the mining building, will be three stories in height, flanked by two main buildings, one the mechanical and the other the chemical building. In the rear of these and inclosing a court will be the service building. Beyond the service building and spanning what is known as Panther Hollow and thus connecting the Bureau of Mines buildings with the Carnegie Schools, will be two buildings over the roofs of which will pass the roadway from Forbes Street to the Carnegie School buildings and Schenley Park.

Between the main group and the power and fuel group will be the entrance to a series of mine shafts. One of these will be used as an elevator to carry heavy material and passengers from the lower level to the upper; another will be for tests of hoisting ropes and similar mining appliances; another will be an entrance to tunnels extending under the buildings and in which mining experiments, such as fighting mine fires, will be conducted.

The portion of Panther Hollow above the power buildings will be arranged as a miners' field, the slopes of the ravine being utilized as an ampitheater which will accommodate 20,000 spectators who may assemble here to witness demonstrations and tests in mine rescue and first-aid.

The main or mining building will contain the administrative offices, and those of the mining force. In it will be an assembly and lecture hall, a library and smoke and other rooms for demonstrations and training in mine rescue and first-aid. The mechanical building will be for experiments and tests of mining machinery and appliances and the chemical building for investigation and analyses of fuels, explosives and various mineral substances.

The buildings now used by the Bureau of Mines as an experiment station at Pittsburgh

were loaned to the bureau by the War Department as an emergency measure when the bureau was created. The War Department has suggested that it now needs these buildings and it is felt the bureau can not retain possession much longer. The buildings are very old and are entirely unsuited to the needs of the Bureau of Mines work. It is said that the investigations have been seriously handicapped by the inadequacy of the structures now in use.

THE FUR-SEAL COMMISSION

The President of the United States and the Secretary of Commerce have approved the recommendation of the Commissioner of Fisheries for the appointment of a special fur-seal commission, to visit the Pribilof Islands during the present season for the purpose of advising the government as to the condition of the seal herd and of making recommendations regarding the policy that should be adopted with reference thereto.

The members of the commission, in accordance with the suggestion of the Commissioner of Fisheries, have been selected by outside agencies and have had no previous connection with the fur-seal controversy.

In response to a request that a duly qualified assistant of the Department of Agriculture, versed in the breeding and other habits of wild and domestic animals, be designated to serve as a member of the commission, Mr. Edward A. Preble, assistant biologist of the Bureau of Biological Survey, has been nominated by the Secretary of Agriculture.

The Secretary of the Smithsonian Institution was requested to name, as a second member of the commission, a person duly qualified to make a critical study of the economic relations and obligations of the government toward the fur-seal herd, the natives of the seal islands, and the fur trade. Mr. Wilfred H. Osgood, of the Field Museum of Natural History, Chicago, has been chosen for this purpose.

The President invoked the National Academy of Sciences to nominate as a third member of the commission a person qualified to study the scientific and economic questions involved in the administration of the seal herd; and Dr. George H. Parker, of Harvard University, has been duly nominated.

Arrangements have been made for sending the commissioners to and from the seal islands on a revenue cutter; they will arrive in the latter part of June and will remain until the second week in August, thus covering the most critical periods of the land life of the seals.

SCIENTIFIC NOTES AND NEWS

The spring meeting of the council of the American Association for the Advancement of Science will be held at the Cosmos Club, Washington, D. C., on the afternoon of Tuesday, April 21, at 4:45 o'clock.

At the general meeting of the American Philosophical Society, held at Philadelphia from April 23 to 25, there will be presented to the society a portrait of the late Samuel Pierpont Langley, a former vice-president.

As has already been noted in Science, the American Chemical Society is holding its spring meeting at Cincinnati, Ohio, during the present week. Each of the sections has a full and important program. At the general session on the first day, after addresses of welcome by the mayor of the city and the president of the University of Cincinnati, and a reply by the president of the society, Professor Theodore W. Richards, the following papers were announced: Arthur L. Day, "The Chemical Problems of an Active Volcano"; L. J. Henderson, "The Chemical Fitness of the World for Life"; W. D. Bancroft, "Flame Reactions"; Irving Langmuir, "Chemical Reactions at Low Pressures."

A portrait of Sir William Ramsay, painted by Mr. Mark Milbanke, has been presented to University College, London, by former colleagues and past students. Professor J. Norman Collie made the address. A replica of the portrait has been presented to Lady Ramsay.

Professor John F. Downey, dean of the college of science, literature and the arts, of the University of Minnesota and professor of

mathematics, will retire in June, 1913, after thirty-three years of service as a member of the Minnesota faculty.

The Cambridge University observatory syndicate has appointed Professor A. S. Eddington, Plumian professor of astronomy, to be director of the observatory.

Mr. Arthur Scott, for some years past a teacher of science in Chili, has been appointed assistant in the Lick Observatory, on the D. O. Mills Foundation, for service in the work of the D. O. Mills Southern Hemisphere Expedition, which at Santiago, through the gift of Mr. Ogden Mills, of New York, is carrying on extensive studies in the movement of stars in the line of sight.

We learn from *Nature* that the first award of the Kelvin gold medal and prize, founded by Lady Kelvin at the University of Glasgow for the best dissertation in natural philosophy presented for the degree of D.Sc. during the three years 1911–13, has been made to Dr. A. D. Ross, now professor in the University of Western Australia. The first award of the William Jack prize (founded in honor of Emeritus Professor Jack), for the best dissertation in mathematics presented for the degree of D.Sc. during the four years 1910–1913, has been made to Dr. R. J. T. Bell, senior university lecturer in mathematics.

Professor John Zeleny, head of the department of physics of the University of Minnesota, has been granted a year's leave of absence, which he will spend in private study and research at Cambridge, England. Professor Anthony Zeleny will act as chairman of the departments during the year 1914–15.

Professor Ludwig Pick, of Berlin, will deliver the Harrington lectures of the medical department of the University of Buffalo, under the title of "Some Advances in Pathological Anatomy."

Dr. Lightner Witmer, of the University of Pennsylvania, and Professor L. C. Coffman, of the University of Illinois, were the principal lecturers at a week's conference of principals and superintendents of city schools, held at the University of Minnesota, March 23–28, with a registration of about 300.

The Bakerian Lecture of the Royal Society was delivered by Professor A. Fowler on April 2, on "Series Lines in Spark Spectra."

Dr. Egbert Le Fevre, dean of University and Bellevue Hospital Medical College, New York City, died on March 30, from scarlet fever, aged fifty-five years.

Dr. John Henry Poynting, professor of physics at Birmingham University, has died at the age of sixty-one years.

Professor G. M. Minchin, F.R.S., formerly professor of mathematics, Royal Indian Engineering College, Coopers Hill, died on March 23, at the age of sixty-eight years.

Dr. G. J. Burch, F.R.S., formerly professor of physics at University College, Reading, has died at the age of sixty-two years.

Professor G. Joachimsthal, of Berlin, chief of the university clinic for orthopedic surgery, has died at the age of fifty years.

The London *Times* reports that Sir John Murray, the oceanographer, who was killed in a motor-car accident on March 16, has by his will bequeathed his books, papers, letters, collections, specimens, furniture, fittings, instruments, and such effects in his Challenger Office at the Villa Medusa, Wordie, Edinburgh, as also the books, etc., property belonging to his scientific library in Challenger Lodge at the time of his death, to his son, whom failing, to his daughters, along with a number of shares in the Christmas Island Phosphate Company, in order that the dividends may be applied in scientific research or investigations or explorations which are likely to lead to an increase of natural knowledge, and especially in the science of oceanography. He expressed the wish that his deep-sea collection of marine deposits and scientific library should be kept together and be cared for by his sons or daughters, the Villa Medusa being used for the purpose, so that scientific work might be carried on there for 20 years after his death. It is suggested that in the case of substantial expenditure the Challenger Society or the Royal Society of London or the Royal Society of Edinburgh might be consulted.

To search the Arctic Circle for the lost Canadian exploration ship *Karluk* the steam whaler *Herman* has left San Francisco. The Canadian government is sending the whaler to the relief of the *Karluk*, which with the greater part of her crew has been missing for several months. It will be remembered that Mr. Stefansson, commander of the expedition, who with three of the crew left the *Karluk* which was fast in the ice, to hunt caribou, could find no trace of the vessel when they returned. The ice had been broken up by a gale and the ship, it is supposed, drifted eastward. Captain C. T. Pedersen, master of the *Herman*, believes he will find the *Karluk* somewhere between Point Barrow and Herschall Island, locked among icebergs.

Nature states that while the various official and private expeditions are making preparations for observing the total solar eclipse of August 21 next, steamship companies are offering pleasure cruises which include a stay on the line of totality on the Norwegian coast. The Royal Mail Steam Packet Company's ocean yachting steamer, *Arcadian*, twin screw, and 8,939 gross tonnage, is timed to leave Grimsby on August 15 and Leith, August 16, and will take up a position near Alsten, north of Torghatten Island, well on the central line. The Norway Travel Bureau of the Great Northern Railway Company has also arranged a special cruise. Passengers leave Newcastle-on-Tyne by the steamship *Venus* on August 15, and join the special steamer *Mira* at Bergen on August 17, a position being taken up at Stokka on eclipse day. It is stated that if a party of seventy-five to eighty members of the Royal Astronomical Society and the British Astronomical Association would avail themselves of this facility no other passengers would be accepted, and the itinerary would be varied to meet the requirements of the party, and the stay at any place in the eclipse zone prolonged.

The Association of Dental Faculties of American Universities met at the University of Minnesota, March 20–21. Dean Owre, of Minnesota, read a paper recommending the adoption by this association of a four-year course in dentistry for all the colleges composing the association. This recommendation was adopted. The deans present at the meeting were: Frank T. Breene, Iowa State College; Edward C. Kirk, University of Pennsylvania; James Sharp, University of California; F. B. Moorehead, University of Illinois, and W. S. C. Hoff, University of Michigan. In addition there were present several members of the faculties of the institutions represented. The dental college of Washington University, St. Louis, Dr. J. H. Kemmerly, delegate, was admitted to membership.

Work is now in progress at the University of Chicago on a building for the Departments of Geology and Geography to be known as the Julius Rosenwald Hall. It will be made of stone, steel and cement and be fireproof in the best sense of the term. The cost will be about $260,000, exclusive of the furniture and equipment. It adjoins Walker Museum and will be connected with it by corridors on each floor. Both buildings will be served by an elevator in the corridor connection. As the plans have been carefully drawn on the basis of large experience, the following list of the appointments may be of interest to geologists and geographers: A museum room, an assembly hall, six class rooms, a seminar room, laboratories for mineralogy, petrology, economic geology, geo-chemistry, macroscopic determination, ore genesis, high temperature and high pressure experiments (outside the main walls of the building), physiographic modeling, dynamical and structural experimentation, lathe and section work, and miscellaneous work, a laboratory-conference room, a seismograph room (with pier carried down to solid rock by caisson), a vault for documents and rare material, three map laboratories with three associated map-conference rooms, a general departmental reading room with accommodations for eighty, a stack room for departmental library with capacity for 66,000 books, with book-lift, and a library work room; a research reading room, five research study-rooms for staff, a staff research room each for geology and for geography, ten research rooms for candidates for Ph.D., a council room, nine

offices for staff, a stenographer's room, a waiting room, a meteorological tower, with a laboratory, a work room and an office, three dark rooms, a goniometer room, a microphotographic room, a room for liquid separation of minerals, five storage rooms, five storage closets connected with class rooms, cloak rooms, lockers and four toilet rooms. The ventilation will be forced by an electric fan in the basement supported by a suction fan near the roof. The exterior of the building will be ornamented with symbolic bas-reliefs representing subjects appropriate to the earth sciences, as well as some of the great leaders in special phases of the science. The contract calls for the completion of the building by the first of November. The paleontologic work will remain in Walker Museum and the two buildings will be used in close relationship.

THE water supply of the great Missouri River drainage area is the subject of a publication recently issued by the United States Geological Survey, entitled "Surface Water Supply of the Missouri River Basin, 1911," by W. A. Lamb, W. B. Freeman and Raymond Richards. This report contains the records of flow at 130 permanent stations of the survey during the year 1911, data which are necessary to every form of water development, whether it be water power, navigation, irrigation or domestic water supply. Some of the tributary streams are exceedingly variable in flow; others, like the Niobrara in Nebraska, are remarkably uniform. A systematic study of Missouri River and its tributaries is being carried on by the United States Geological Survey. Considering the varied character of the streams of the Missouri River basin and their great economic importance for irrigation, power and other purposes, the investigation is one of importance. The Missouri proper is formed in southwestern Montana by the junction of three streams which were discovered by Lewis and Clark in 1806 and were named by them Jefferson, Madison and Gallatin Rivers. Of these three Jefferson River drains the largest area and is considered the continuation of the main stream. This part of Montana is mountainous and affords many excellent water-power sites. Among the principal tributaries of the Missouri are the Marias, Musselshell, Yellowstone, Cheyenne, Platte and Kansas. The western part of the basin is in the arid belt and the eastern part is in the semiarid and humid regions. Ten states are drained in part by Missouri River. Rising at the Red Rock Lakes, at an elevation of 6,700 feet above sea level, this stream descends through the Rocky Mountains and emerges on the broad prairie land a few miles below the city of Great Falls, Mont. From that point it is accounted a navigable stream with an easy grade, and in passing through the Dakotas and along the borders of Nebraska, Kansas and Iowa it receives the flow of great tributaries, so that as it crosses the State of Missouri and joins the Mississippi a short distance above St. Louis, it becomes one of the large rivers of the world. Its total drainage area is about 492,000 square miles in extent and comprises, in addition to the states above mentioned, large areas in Wyoming and Colorado and a smaller area in the southwestern part of Minnesota. On Shoshone River in Wyoming, a tributary of the Bighorn, which in turn is tributary to the Yellowstone, which joins the Missouri in eastern Montana, is located the Shoshone dam, the highest structure of its kind in the world, 328 feet from foundation to capstone. This structure was erected by the government to impound water for irrigation on the arid lands in the valley of Shoshone River below. Another great structure of a similar kind is located in Wyoming on North Platte River, which joins the Missouri near Omaha, Nebr. This is known as the Pathfinder dam, and was also erected by the government to impound water for use in the irrigation of lands in Wyoming and Nebraska. Another notable engineering structure in the drainage basin of the Missouri River is the Belle Fourche dam, erected across the river of the same name in South Dakota by the government to impound water for irrigation. This dam is an earth embankment 155 feet high and one and one fifth miles long, containing 1,600,000 cubic yards of earth fill. This is the largest earth dam in existence.

UNIVERSITY AND EDUCATIONAL NEWS

A CONTRIBUTION of $50,000 from Mrs. E. H. Harriman to the endowment fund of Barnard College, Columbia University, is announced toward the million dollar fund now being raised for the twenty-fifth anniversary of the institution $550,000 is now pledged.

DR. J. B. JOHNSTON, professor of neurology in the department of anatomy of the University of Minnesota, has been appointed professor in the department of animal biology in the College of Science, Literature and the Arts, and dean of that college from August 1, 1914.

RICHARD LABAN ADAMS, a graduate of Massachusetts Agricultural College and M.S. of the University of California, has been appointed assistant professor of agronomy in the University of California. James Alexander Armstrong, a graduate of 1910 of the University of California, and now chief chemist of the Union Sugar Company at Betteravia, California, has been appointed field assistant in agricultural extension in the university.

DR. E. G. KENNARD, of Cornell University, has been appointed instructor in physics at the University of Minnesota.

MR. A. V. HILL has been appointed to the Humphrey Owen Jones lectureship in physical chemistry, at the University of Cambridge.

DISCUSSION AND CORRESPONDENCE

GYROSCOPIC QUANTA

IN the note[1] on gravitationally produced vortices in the ether and their relation to Planck's quantum theory, attention should perhaps have been called to some additional deductions.

For example, that it necessarily follows from the writer's electrostatic-doublet vortex theory of matter,[2] that the energy radiated when a distortional ether wave strikes an atom will be given off in quanta and be proportional to the frequency.

The simplest way of seeing this is to take the well-known experiment in which a gyroscope is held in the hand and the body revolved first in one direction and then in the other. On turning the body in one direction no effect is produced on the gyroscope. On turning in the other direction the gyroscope resists and is upset, and the axis then points in the opposite direction.

It may easily be shown that the amount of work done in upsetting the gyroscope varies directly as the angular velocity of rotation of the body, *i. e.*, in the case of the atom and ether wave, is directly proportional to the frequency.

It will be seen that this type of atom is somewhat different from any of those heretofore proposed. For example, instead of the electrons being numerically equal to one half the atomic weight the electrons can be numerically equal to the atomic weight, but only one half of them affected by any given ether displacement.

In addition, the stable equilibrium conditions of this type of atom are comparatively simple and the positive nucleus may be made to vanish, *i. e.*, can be formed of a number of negative electrons as pointed out in a previous paper.

REGINALD A. FESSENDEN

BROOKLINE, MASS.,
March 1, 1914

[1] SCIENCE, October 17, 1913.

[2] See papers referred to 1889–1900 in previous note.

MULTIPLE FACTORS IN HUMAN SKIN COLOR

A RECENT article by E. C. MacDowell[1] on "Multiple Factors in Mendelian Inheritance" is highly significant in its explanation of cases of apparently "blended" inheritance. The author gives a clear historical summary of experiments made by various investigators, beginning with Nilsson-Ehle's studies on oats and wheat first published in 1909. The original work reported is upon sizes in rabbit hybrids. It is a continuation of Castle's well-

[1] *Jour. Exper. Zoology*, Vol. XVI., No. 2, pp. 177–194, 1914.

known studies and was carried out with Castle's own material and with his cooperation and help. The experiments now reported show that the Nilsson-Ehle explanation of "blended" inheritance (*i. e.*, two or more non-allelomorphic factors producing phenotypically similar phenomena) may be applied to size differences in hybrid rabbits.

The fact that crosses between negroes and whites give mulattoes has long been pointed to as proof of "blending." But, as is well known, various pigments are here involved, viz., black, red and yellow. Davenport[2] has shown clearly that the children of two mulatto parents exhibit great variation in color. Occasionally some are light enough to "pass for whites" when away from home. The explanation of this phenomenon, as based on multiple factors, is suggested by Davenport. In the light of MacDowell's own work and the work that he cites there can be little doubt of the correctness of this view. Probably there are separate factors (determiners) for the several pigments and more than one, perhaps many, for the black pigment.

A quotation from MacDowell's paper shows the conclusions drawn from his studies of rabbits. But his statements may be applied to human skin color and, no doubt, to many heritable characters of human beings:

> Offspring from crosses between extremes are generally of an intermediate nature. In the following generation new forms appear that are similar to the original parents or even more extreme. The greater number of individuals are intermediate. In certain cases crosses between similar lines, after a first generation like the parents, give a second generation in which a wide range of grades appear. These are the facts definitely ascertained from the work that has been done. . . . The interpretation of multiple factors can be applied to all the facts. It goes hand in hand with the mutation and pure-line doctrines of de Vries and Johannsen, and in its breadth of application, and its comprehensive simplicity, this theory, based on the assumption of the segregation of distinct units, is very attractive; by its use as a working hypothesis important facts have been discovered; its acceptance and further development will help to establish a broad and unified system of heredity.

Doubtless many "well-informed" persons still hold to the idea of "blended" inheritance. It is with the hope of calling attention to the Mendelian phenomena involved that this note is submitted. A careful reading of MacDowell's article will clear up many puzzling difficulties for those who are interested in heredity but have not kept up with the literature of the past few years.

FRANCIS RAMALEY
UNIVERSITY OF COLORADO,
BOULDER, COLO.

[2] "Heredity in Relation to Eugenics," pp. 36–38, New York, 1911.

DIADOPHIS PUNCTATA IN NORTHERN WISCONSIN

RUTHVEN[1] has recorded the occurrence of the ring-necked snake, *Diadophis punctata* (Linnæus), at Marquette, Michigan, on the strength of specimens having "been taken by Dr. Downing," but later the same authority states: "The Marquette record is particularly open to question and has not been recorded upon the map."[2] Not having seen a specimen from Marquette, Ruthven was perfectly justified in making his later statement, in view of the fact that the locality was considerably beyond the known northern geographic range of the species. It may be interesting, however, in this connection to note that on July 5, 1912, I collected a specimen of this species near Rhinelander, Oneida county, Wisconsin, a locality about 120 miles west-southwest of Marquette, Michigan. The snake was found, one and one half hours after sunset, extended full length across the wheel tracks of a sandy road bordering low second-growth woods of *Pinus divaricata*, *Betula papyrifera*, *Populus tremuloides* and *Quercus coccinea*; in the late twilight the animal was scarcely visible from the wagon in which I was driving. It made no resistance to being captured, was perfectly docile, and soon became tame. It showed a tendency towards positive reaction to contact

[1] Ruthven, A. G., 1906, Report Geol. Surv. Michigan for 1905, p. 111.

[2] Ruthven, A. G., Thompson, C. and Thompson, H., 1912, "The Herpetology of Michigan," Michigan Geol. and Biol. Surv., publ. 10, p. 107.

stimuli and a negative reaction to strong light, factors which may, in part, determine the nocturnal and hiding habits of this species. Unfortunately I was not favorably situated at the time for an extensive study of the habits and behavior of the animal, and it was, therefore, the next day preserved as a specimen.

On account of the rarity of this species in the northern part of its geographic range it seems that a brief description of this specimen is not amiss. The general color of the back can best be described as dark bluish olive-brown; the ventral parts, labials and neck-band (two scales wide) are salmon pink, being slightly darker postero-ventrally and sightly more yellowish on the supralabials and neck-band; a series of about 40 small black spots are scattered irregularly in a single midventral line from the 41st to the 144th ventral plates, being more numerous between the 86th and 144th ventral plates. The total length is 335 mm.; tail, 80 mm. The scutellation is as follows: dorsal scale rows, 15; ventrals, 156; subcaudals, 53; supralabials, 8–8; infralabials, 8–7; oculars, 2–2; temporals, 1–1.

Hartley H. T. Jackson

U. S. Department Agriculture

SCIENTIFIC INSTITUTIONS MINUS SCIENCE

In recent years the question has much occupied the public mind whether fraternities in schools and colleges are desirable or not. Those who favor the negative, often point to the low scholarship of the members of fraternities. The fraternities have reacted by strenuous efforts to raise the scholarship among their members. One of the national organizations recently offered a loving cup to that chapter in a group of universities of the Middle West which would make during the year the highest scholarship record. The national officers asked two members of the faculty of the University of Missouri to select the chapter. That ought to be easy. But it was found impossible. To make such an award, it is not sufficient to know that each chapter got so many A's, B's etc., or so many 95's, 90's, etc., whatever the symbols may be in each institution. It is absolutely necessary to know the frequencies of these grades in the whole student body of the institution. But none of these institutions, except one, could furnish these data, although, without the frequencies being known, their grades are practically meaningless. Here, then, we have institutions which are generally regarded as the representatives of science. But to apply science to the grades, of which they record year after year thousands, and without which they appear to be unable to get along, that does not seem to have occurred to the administrations of most of them. Their alumni look with amazement upon their *alma maters* which can not furnish the data for the solution of so simple and so proper a problem as that of awarding a loving cup to a group of students who have distinguished themselves by their scholarship.

Max Meyer

University of Missouri

THE LANGUAGE OF THE BRAZILIAN PEOPLE

To the Editor of Science: Regarding the review of the work entitled "Fosseis Devonianos Do Paraná," published in the March 13 issue of Science by Dr. Chas. K. Swartz, Baltimore, Md., in the last paragraph where it mentions the work done by Dr. John M. Clarke, for the Department of Agriculture, Commerce and Industry (Geological and Mineralogical), I find a mistake in his stating that the work is published in the English and Spanish languages in parallel columns. Mr. Swartz should have said that it is published in Portuguese and English, the former being the universal language of the Brazilian people.

E. Braga

QUOTATIONS

PROFESSORS IN COUNCIL

In the circular letter that was sent out in the spring of 1913, looking to the formation of a national association of university professors, the motive actuating the signers was indicated in the statement that, besides his interest in his specialty, the university professor is "concerned, as a member of the legis-

lative body of his local institution, with many questions of educational policy which are of more than local significance"; also that "he is a member of a professional body which is the special custodian of certain ideals, and the organ for the performance of certain functions essential to the well-being of society." And the general purposes were declared to be "to promote a more general and methodical discussion of the educational problems of the university; to create means for the authoritative expression of the public opinion of the profession; and to make possible collective action, on occasions when such action seems called for." The letter was sent out by Johns Hopkins professors to members of the faculties of nine other universities, and the response was favorable in all cases; a conference on the subject was held last November; and now announcement is made of the names of a committee, representing the chief departments of learning and nearly all the leading universities of the country, whose task it will be to take the steps necessary for complete organization.

The distinctive feature of the American university is the part played by the president. Nothing even distantly resembling it exists, we believe, in any European country. That he is not the absolute monarch he is sometimes represented as being is true enough; but the limitations upon his power are often of the same nature as those which have as a general rule obtained in the case of what are usually designated as absolute monarchies in the history of nations. No university president thinks of setting up his personal will as the sole guide of his policy. Apart altogether from such check as may be exercised by the board of trustees, or other formal governing body, he usually consults the chief professors in any matter relating to their respective departments; and moreover there exists in every university some form or other of faculty organization. Nevertheless, the president, in most American universities, is the center of power, the chief fountain of favor and disfavor, of advancement or retardation; and his disposition towards any question, whether relating to an individual or to a principle of policy, usually has, or may have if he chooses, the controlling influence in its determination.

This feature of the American university system has been the subject of endless comment; but there exists alongside it, and somewhat resembling it in nature and effect, another feature that has attracted less notice. What goes on within any university is, in a certain sense, its own private affair; and it may easily happen that it is not the president, but one or more professors or professorial cliques, in whom real power rests, and by whom it is improperly exercised. Now there has not been developed in our country either any central organ—such as the Ministry of Public Instruction in European countries, for example—or any well-defined body of university tradition, to operate as a check upon any bad tendencies or unjust practises which may thus develop in any given institution. When such a state of things arises, whether the blame for it belongs to president or to professors, all that is apt to happen is a certain amount of grumbling, perhaps of indignation; it is only in extreme cases that there is likely to be any overt action. It may be that some professor is the victim of downright persecution; it may be that manageable mediocrity is systematically preferred to high ability which is somewhat more difficult to handle; it may be that independence of thought or freedom of speech is frowned upon and discouraged. Whatever the trouble may be, appeal is impossible to any but the little circle within the university itself, which is to all intents and purposes a close corporation.

That the new association may supply to the American university professor a basis for a wider and more catholic appeal in questions of moment, that it may become the means of promoting a professional spirit at once finer and stronger than that which has hitherto been general, must be the hope of all who are interested in the most truly distinctive service which universities render to a nation. Upon their immediate promotion of the general welfare, not only through the diffusion of intelligence and the improvement of education, but

also through efforts expressly directed to economic and social ends, emphasis has been laid in these latter days as never before. This tendency is bound to continue; and the benefits that will flow from our universities in these ways are quite beyond calculation. But it is not difficult to imagine these results obtained by other instrumentalities, if the institution we call the university were not historically in existence, and ready to furnish them. The thing that the university alone can supply—the thing, at all events, for which neither history nor imagination suggests a possible substitute—is the preservation of high intellectual ideals, the maintenance of noble traditions of science and learning. Of these ideals and traditions university presidents, however masterful, university administrators, however efficient, can not possibly serve as the custodians. It is upon the men whose business is not to administer but to teach and to learn, not to manage but to investigate and to inspire, that we must depend for the keeping alive of the sacred fire. And if we read aright the announcement of its purposes, it is to the strengthening of this conception of the professor's status that the new association is above all to be devoted.—New York *Evening Post.*

SCIENTIFIC BOOKS

The Scientific Work of Morris Loeb. Edited by THEODORE W. RICHARDS. Harvard University Press. 1913.

The many friends of Dr. Morris Loeb will feel very grateful to Professor Theodore W. Richards for arranging this volume. It is the best monument yet erected to the memory of a man whose life was an inspiration to all who knew him.

The first part of the volume is a collection of some lectures and addresses referring to chemical research, the Chemists' Club building, the chemical museum and kindred subjects. The great idealism of Dr. Morris Loeb, combined with his practical, well-organized methods and conceptions, are well illustrated by some passages:

Pages 95–96: ". . . How, then, can the status of the independent commercial chemist be raised in our city? By giving him a central rally-point; a home that proves to the layman that his is a skilled profession, not a mere job-hunting trade; a place where the manufacturer or merchant can find the man he wants without a rambling search through the city directory. Doubtless, some of our colleagues are so well known that all the business comes to them which they can handle. But the many additional independent chemists, whom our commercial situation demands, can only establish themselves if they can secure proper laboratory facilities, without hiring attics in tumble-down rookeries. . . ."

Page 96: ". . . Every year scores of New Yorkers graduate in chemistry from our local institutions and return from years of protracted study in other American and European institutions. They are enthusiastic for research; in completing their theses they have laid aside definite ideas for subsequent experimentation; but they have no laboratory. While waiting to hear from the teachers' agency where they have registered, while carrying on desultory correspondence with manufacturers who *may* give them a chance, they do not venture upon expenditure of time and money to fit out a private laboratory, which they may be called upon to quit any minute upon the appearance of that desired appointment. Often necessity or tedium will cause them to accept temporary work of an entirely different character and indefinitely postpone the execution of the experiments which they had mapped out. Who will estimate the loss of scientific momentum, the economic and intellectual waste, which this lack of laboratory facilities for the graduate inflicts upon New York, as compared with Berlin, Vienna, Paris and London? Either our universities and colleges, or private enterprise, should provide temporary desk-room for the independent research chemist."

Pages 98–99–100: ". . . There is still another point, however, in which the American chemist is at a great disadvantage as compared with the European; the ease of securing material for his research and of comparing his

results with those of others. In Europe, especially in Germany, research is never seriously delayed by lack of a needed preparation, whereas, none of our supply houses carry a full stock of chemicals. To obtain a single gram of some particular substance, needed for a few preliminary tests, frequently causes weeks of delay, as well as the disproportionate custom house and brokerage expenses involved in the importation of small quantities. Besides, owing to the better centralization of scientific laboratories in Europe, and the existence in each case of a fairly complete set of specimens accumulated in the researches of large numbers of academic investigators, it is comparatively easy to obtain by correspondence research material or typical specimens for comparison. In this country, on the other hand, laboratories are scattered throughout the numerous colleges and universities, and there are no established rules by which specimens must be deposited with the laboratory. In smaller laboratories, especially, the chances of preservation after the departure of the investigator are not very good. It would be, consequently, very much more difficult to obtain such specimens here. I would suggest, therefore, that a chemical museum be established in New York, to perform for the American chemists the functions that the Smithsonian Institution so admirably carries on for the benefit of American naturalists. This museum would not attempt to be a popular show-place, but would embody, in the first place, as complete a collection as possible of chemically pure materials of the rarer kinds, so as to supplement, but not in any manner compete with, the stock of commercial supply-houses. Any scientific investigator would be entitled to borrow or purchase material required for immediate experimentation, and all used articles would be replaced as quickly as possible.

In the second place, it would be a depository for specimens of new substances obtained in American research. Every chemist would be invited to send to the museum a small quantity of each substance newly prepared by him, not, indeed, as an evidence of the good faith of his investigation, but, rather, to enable future workers to obtain such material, either for comparison, or for further experimentation with the least possible delay. Many substances that are now carried away from universities by students who subsequently abandon chemical research, or which belong to the families of deceased chemists who do not know what to do with them, would thereby be rescued from oblivion, and might ultimately become of the greatest value for a special purpose.

Thirdly, this museum would invite chemical manufacturers to send standard samples of their products, and thereby facilitate the commercial relations between consumer and manufacturer.

To such a museum there could be attached a competent staff of workers for the preparation of samples not otherwise available. In the analysis of samples submitted as official standards, we should have the beginning of that Chemische Reichsanstalt which is now the chief object to which German chemists are directing their attention."

Page 126: ". . . We have detailed some of the more striking advantages which the new building is expected to confer upon the chemical profession as a whole, as well as upon its individual votaries; is it an exaggeration to characterize the constitution of the Chemists' Building Company itself as a new era in the chemical industry of our country? In scanning the list of shareholders, we find representatives of nearly every important concern, or even the larger companies themselves; but that this is not a 'trust,' in the sense so obnoxious to the yellow journalist, is demonstrated by the conditions of the partnership. No shareholder can receive more than 3 per cent. dividends, and the surplus can not, under any circumstances, accrue to his benefit within the next fifty years. This association, therefore, is not for individual profit, but for the raising of the standards of chemical industry and research in the United States. If we recognize what the Verein zur Hebung der chemischen Industrie, founded by Hofmann and Werner Siemens, has done for

Germany, we may well hope for further fruits of this initiative here. Perhaps this building will house joint laboratories for the solution of questions affecting all manufactures alike; or experimental stations for the study of natural products not yet utilized; or a cooperative bureau of standardization for analytical methods; or a national welfare bureau for employees in chemical factories. This building does not owe its erection to some benevolent demigod, extending his protecting wing over people unable to care for themselves; it is a building by the chemists, of the chemists, and for the chemists. May it ever serve as an exemplar of unselfish patriotic cooperation!"

Pages 128–129: ". . . For, strange as it may seem to the layman, who has seen the ugliest blots on a landscape designated as chemical factories, who has sniffed with disgust a chemical odor, has been urged to believe that the chemist's shadow contaminates pure foods, and has been taught in school that alchemy spelled fraud and sorcery, our science is one calculated to develop the ideal side of human nature, and the chemist, more perhaps than the votary of natural science or the devotee of the so-called humanities, is led to an intense interest in human development. . . ."

Page 129: ". . . Our science aspires not only to know, but also to do. On the one hand, it leads us to delve into the secrets of nature, in the minute atom as well as in the far distant stars, in the living cell as well as in the crystallized relics of the convulsions from which this earth was born; on the other, it leads us to apply this knowledge to the immediate needs of man, be it in safeguarding his health, in ministering to his material or esthetic wants, or in regulating his commerce and in facilitating his utilization of the earth's resources. . . ."

". . . There are two ways of aiding a man or a cause: by addition to the income or reduction of the expense. The pecuniary result to the beneficiary may be the same, but the moral one is far different; it is not only the beggar who is pauperized by the cash gift and uplifted by the aid which enables him to earn his own livelihood. Arts and sciences may be stimulated by prizes and scholarships beyond a doubt, but the relation between donor and recipient is not free from restraint and the probability of human error in the selection of the right incumbent makes the method a wasteful one at best. . ."

Part I. contains also his lectures on the "Fundamental Ideas of Physical Chemistry," "Osmotic Pressure," "Electrolytic Dissociation," "Atoms and Molecules," "Hypothesis of Radiant Matter," all models of clear exposition of difficult subjects.

The 170 pages of the second part of the volume relate exclusively to original experimental investigations carried out by Morris Loeb since 1885. His latest contribution "Studies in the Speed of Reductions" was read by him at the International Congress of Chemistry in 1912, a few days before his untimely death, which took him away in the prime of life, from his family and his many friends.

L. H. BAEKELAND

YONKERS, N. Y.

Curious Lore of Precious Stones. By GEORGE FREDERICK KUNZ. Philadelphia and London, J. B. Lippincott Company. 1913. Pp. xiv + 406. Six color plates, 22 double tones and 24 line cuts.

The object of this book, as stated in the preface, is to "indicate and illustrate the various ways in which precious stones have been used at different times and among different peoples, and more especially to explain some of the curious ideas and fancies which have gathered around them. Many of these ideas may seem strange to us now, and yet when we analyze them we find they have their roots either in some intrinsic quality of the stones or else in an instinctive appreciation of their symbolic significance. Through manifold transformations this symbolism has persisted to the present day."

To the interesting task thus outlined Dr. Kunz has brought a lifelong familiarity with gems, knowledge gained by the formation of several collections illustrating the folk-lore of precious stones and the possession of what is

on this subject probably the most comprehensive library in the world. That Dr. Kunz treats the subject sympathetically is to be expected; that he will lead others to similarly regard it is a probable and desirable result of his book. Whoever thinks that superstition is dead among civilized peoples and that only in an age of darkness could a belief in the powers of such insensate bits of matter as gems gain credence, should read the chapter on "Ominous and Luminous Stones" and learn how the innocent and charming opal, regarded entirely without prejudice in the sixteenth century, came, in the nineteenth century, to be invested with fear and dread. All jewelers know that the superstition regarding the opal at the present day seriously interferes with its sale even among the most enlightened. Dr. Kunz evidently would not desire to perpetuate superstitions regarding precious stones, but that they should be invested with sentiment he approves. Thus in the chapter in birthstones (a subject which he treats exhaustively) he says:

"Sentiment, true sentiment, is one of the best things in human nature. While if darkened by fear it may lead to pessimism, with all the evils which such a state of mind implies, if illumined by hope it gives to humanity a brighter forecast of the future, an optimism that helps people over difficult passages in their lives. Thus, sentiment must not be neglected, and nothing is more likely to destroy it than the conviction that it is being constantly exploited for purposes of commercialism. For this reason, the interest as well as the inclination of all who are concerned in this question of birthstones should induce a very careful handling of the subject."

And again,

"Sentiment may best be expressed as the feeling of one who, on a warm summer's day, is rowing along a shady brook or resting in some sylvan dell, with nothing to interfere with his tranquil mood and nothing to spur him on to action; thus he has only suggestions of hope and indulges in rosy views of life. Reality, on the other hand, may be likened to a crisp winter's morning when one is filled with exhilaration, conscious of the tingle of the cold, but comfortable in the knowledge of wearing a tightly buttoned garment which will afford protection should the elements become disturbing. Superstition, lastly, may be said to resemble a dark, cold, misty night, when the moon is throwing malevolent shadows which are weird and distorted, while the cold seems to seize one by the throat and arouse a passionate desire to free one's self from its grip in some way, to change a horrible nightmare into a pleasant dream."

It is probable that it is in the explanations which he gives of the causes of the "curious ideas and fancies" which have gathered around precious stones that Dr. Kunz makes his most important contribution to the subject of his book. So far as the present writer is aware, this has never been attempted before so carefully, or at least with so keen a sense of the mutual relations of the various factors involved. Thus the results of crystal gazing are shown to be due to hypnotism; fancy for birthstones to tradition; the powers of colored stones to color effects, and so on. Besides those already mentioned, some of the subdivisions of the subject treated are, "Talismans and Amulets," "Engraved and Carved Gems" and "The Therapeutic Use of Precious Stones."

As a compendium of the virtues and powers ascribed to precious stones, this work is probably not entirely exhaustive, but it is not meant by this statement to imply that the book is not comprehensive. An exhaustive catalogue of the various attributes of precious stones would probably lack the readableness with which Dr. Kunz has succeeded in investing his work in a remarkable degree. In typography and illustrations the book exhibits the sumptuousness which has always marked Dr. Kunz's works. Some further indication than is given of the size of the objects represented in the plates might be desirable and one could wish more of the jewels to have been represented in color. These are, however, but slight shortcomings in a book which can hardly fail in any part

to interest the student of precious stones and of mind.

Oliver C. Farrington

The Anarchist Ideal and Other Essays. By R. M. Wenley.

This contribution of Professor Wenley's must be accepted as it is offered, as a record of varied interests. The topics considered, which in part appeal to the man of science, are various. The essay which gives the name to the volume is entirely retrospective in its view and supplies a parallel in Greek life for the independence of thought and the revolt from established conventions, of which theoretical position the anarchist is a practical and an extreme expression; it is a study of the intellectual sources of the anarchist position. Its value consists in broadening the historical aspect of movements which in their modern setting are overshadowed by local situations. Similarly retrospective is the essay upon "Plutarch and His Age." The central position in the volume is given to a review of the early movement towards physiological psychology. This is an able presentation of the philosophical positions which preceded and guided the formation of psychology as a scientific pursuit. The complex origins are traceable primarily to German philosophers as well as to such men as Weber, Fechner, Lotze, Helmholtz and Wundt, whose philosophical interest was joined to their more rigidly scientific investigations. It is Professor Wenley's purpose to supply not a narrative of the contributions of these men, but rather an interpretation of the intellectual movement which guided them towards the consummation to which they severally but differently contributed. On the whole the two educational essays, the one on "Heredity and Education" and the other on the "University in the United States," give ampler opportunity for Professor Wenley's individuality of thought and for the display of the temper of his opinions. By long residence a member of the professorial guild in this country, yet by training and tradition equally at home in the intellectual perspective of English and Scottish universities, he is in a peculiarly favorable position to perform the functions of comparative criticism which he judiciously exercises. Considerate alike of the inevitable shortcomings of educational provisions in the pioneering stage and of the success which has attended them, he retains the fundamental critical attitude in view of old-world standards; he retains also the rare gift of seeing things as they are, despite the enveloping fog which optimism so commonly breeds. The chief note of his complaint is the neglect of individuality and the lack of professional opportunity within academic life for the man of parts, whose development does not conform to the conventional channels of preferment. In a like sympathetic spirit he attempts to portray for English readers some of the peculiar problems which beset American universities, and does so with remarkable success. From beginning to end the volume is characterized by a directness of statement and an insight into relations which gives the whole a higher value than the seemingly casual treatment suggests.

Joseph Jastrow

THE PHYLOGENETIC RELATIONSHIPS OF THE OYSTERS

Dr. Jaworski, of Bonn, has given in the "Zeitschrift für Induktive Abstammungs- und Vererbungslehre" an interesting discussion of the phylogenetic relationships of the oysters. The material upon which he bases his new *Ostrea* genealogy was collected in the middle Jurassic (Dogger) of northern Peru.

Jaworski's theory is based on the discovery of a new ostreid in the Peruvian Jurassic of considerable dimensions—approximately those of a large *Ostrea virginica*, though much more massive—characterized by (1) incurved and strongly gyrate umbones (those of *Ostrea sensu stricto* are approximately straight); (2) by a broad and greatly elevated hinge area (that of *Ostrea* is moderately low, and either broad or narrow); (3) by a ligament partly internal and partly external, located in large measure behind the beaks and produced beyond the hinge area proper (that of *Ostrea* is wholly

internal, medial in position, and confined strictly within the hinge area); (4) by the presence of an anterior adductor muscle impression indicating the persistence of the anterior adductor in the adult stage (in *Ostrea*, the anterior muscle has been observed by a number of embryologists in larval forms though never in stages later than the nepionic); (5) by the presence of pedal impressions indicating a well-defined, though probably reduced foot (in *Ostrea*, the locomotor organ is the velum which persists throughout the free swimming stage, and the presence of a well-defined foot and byssus have never been established even in the embryo).

These observations have led Jaworski to the theory that the new form, the *Heterostrea steinmanni* Jaworski, represents the mid-Jurassic ancestral type from which the true oysters of the Cretaceous, Tertiary, and Recent were directly derived. In order to establish this new hypothesis, it is necessary to first overthrow some of the critical work that has already been done along this line and from which quite different conclusions have been drawn. The three most notable researches are those made by Jackson, of Harvard, Douvillé, of the French Geological Survey, and Steinmann, of Bonn. Jackson's work was done at the Museum of Comparative Zoology, and his approach to the problem was by way of the embryology of the oyster and a number of closely related mono- and heteromyarian groups. The oysters were watched through all stages of development of the egg, the spat encouraged to attach themselves to transparent media and the growth phenomena studied under magnification. He was thus able to confirm and elaborate many of the observations of Huxley, Horst and Brooks, notably those on the number and position of the adductor muscles during the earlier development of the form.

Ostrea, like all other pelecypods in which the embryonic development has been carefully worked out, passes through a monomyarian stage in which, curiously enough, the single adductor muscle is anterior in position, although it is not the antecedent of the anterior adductor of the adult. Then there is a short period at the end of the prodissoconch and the beginning of the dissoconch stages in which both the anterior and posterior adductors are present and typically dimyarian in position. About the third day after the animal has become attached, the anterior adductor evanesces, and only the posterior remains. The atrophy of the anterior adductor has been explained by purely mechanical action: in the dimyarian stage, the orientation of the soft parts is similar to that of the typical pelecypod; the mouth is approximately midway between the hinge line and the ventral margin and the antero-posterior axis is approximately parallel to the hinge; as soon as the spat become fixed, there is a shifting of this axis through almost 45 degrees so that the mouth lies close up under the hinge. This change in position brings the anterior adductor so near the hinge that it loses most of its efficiency; there is, therefore, a compensating increase in the size and effectiveness of the posterior adductor which is gradually shifted to a point of vantage near the central portion of the valves.

The character and mode of development of the soft parts, as a whole, have led Jackson to the belief that *Ostrea* is the sessile analogue and the direct descendant of the free swimming *Perna*. The difference in habit would readily explain the unequal valves and the absence of the foot in the one form and the equal valves and well-developed foot in the other. *Perna* is characterized, however, by a series of vertical cartilage grooves while in typical *Ostrea* there is a single trigonal sub-umbonal pit. Jaworski's criticism of Dr. Jackson's theory of the relationships seems pertinent: the very fact that the young of *Perna* possess a single sub-umbonal pit similar to that of *Ostrea* and the adults a series of pits implies a highly specialized type. The similarity of the young of *Ostrea* and *Perna* may very properly be due to descendence along collateral lines from a common aviculoid ancestor, but there is small evidence of any more direct relationship. Jackson considers *Exogyra* and *Gryphæa* derivative forms of *Ostrea* which have become highly modified.

Douvillé, like Jackson, considers the oysters as direct descendants of true aviculoids not from *Perna*, however, but from *Lima*. The sessile aviculoids are cemented, as a rule, by the right valve, while in the oysters it is the left valve that is attached. However, it is probable that Douvillé overvalues the systematic importance of this character, for in the inequivalved Pectens it is sometimes the right valve and sometimes the left which is the more convex. *Lima*, a significant fact to Douvillé, assumes an almost vertical position as indicated by the approximately equal valves and the presence in both of a byssal opening. Furthermore, the characters of the ligament are similar in the Ostreas and the Limas. The *Ostrea*, however, does not apparently attach itself by a byssus at any stage in its development. Jackson watched very carefully for such a phenomenon, but was unable to find any trace of it. On the contrary, the spat appear to attach themselves at the very beginning of cementation by the margin of the reflected mantle. If the Ostreids were the direct descendants of *Lima*, as Douvillé believes, they would probably reveal to a skilled embryologist such as Jackson some clue to the presence of a former attachment.

Two major groups of Ostreids have been established by Douvillé: in the one, he has assembled all the dominantly smooth forms, in the other, all the dominantly plicate. In both groups, he finds forms with straight umbones and those with gyrate beaks, and the outline of the species is, in his opinion, directly associated with the environment. Thus, the straight-beaked *Pycnodonta* is characteristic of deep and quiet waters, while forms with strongly twisted umbones, such as *Exogyra*, are developed in the more shallow waters, where there are strong currents to be resisted. If this theory be accepted, it is difficult to account for the frequent association of *Pycnodonta* and *Exogyra* in considerable numbers in the same marl bank. In his correlation also of the sculpture of the plicate group with their environment, his theories seem unwarranted by the facts. It is true, to be sure, that, as a rule, the right valve of the Ostreids is less vigorously sculptured than the left, but there is no evidence that the sculpture evanesces more rapidly in the littoral forms. On the contrary, a strong ribbing is most frequently developed where the need for resistance is greatest.

Douvillé as well as Jackson considers the *Gryphæas*, *Pycnodontas* and *Exogyras* as derivatives of the true oysters. Jaworski does not admit, however, that the Ostreids of the Triassic which have served as the theoretical ancestral types are true oysters. Steinmann traces the ancestors of the group even back of the Mesozoic and considers *Eurydesma* of the Permo-Carboniferous of Australia and India as the true ancestor of the Ostreid stock. This form is characterized by a heavy, lamellar shell, prosogyrate beaks, a marginal, posteriorly produced ligament, and possibly an incipient dentition. The most significant feature, namely, the character of the muscle impressions, is doubtful: the form has been commonly accepted until recently as monomyarian. Morris, however, observes "there is one large impression posteriorly and perhaps a small one anteriorly." If the presence of an anterior as well as a posterior scar can be established, *Eurydesma* would, in the opinion of Jaworski, fall in line behind *Heterostrea;* if its absence can be proved, *Eurydesma* should be considered as the ancestral form of the *Gryphæas* and *Exogyras*. It is *Heterostrea steinmanni* Jaworski which its describer considers the true ancestor of the true oyster.

The line of development between the two forms is, in his opinion, well defined, and easy to follow: the degree of coiling of the umbones is functional upon the ratio of the size of the left valve to the adhering surface; the larger the area of cementation, the stronger the tendency toward an elongate outline and straightened umbones; with the change in the direction of the beaks, there is a corresponding shift of the ligament from its original position along the posterior margin to a more effective point of attachment directly beneath the tips of the umbones. The obsolescence of the anterior adductor is doubtless the result of the shift of the antero-posterior axis consequent

upon the readjustment of the soft parts of the animal.

Jaworski evolves and develops another theory of phylogenetic relationship which seems so untenable that it may be disregarded—namely that the strongly plicated oysters such as the *Ostrea edulis* are the descendants of the strongly plicate *Gryphæas* of the Mesozoic. The surface sculpture is not a fundamental character among the oysters and there is no reason to search for its cause in distant ancestral relationships. Regarding the phylogenetic significance of *Heterostrea steinmanni* it would seem that it was an entirely too specialized form to have given rise to the subsequent *Ostrea* stock.

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SPECIAL ARTICLES

THE CHEMICAL DYNAMICS OF LIVING PROTOPLASM

Van't Hoff's formulation of the laws of chemical dynamics has proved so stimulating to various fields of chemistry that it may be expected to be similarly useful if it can be applied to the activities of living protoplasm.

The writer finds that by measuring the electrical resistance of living tissues it is possible to follow the progress of reactions in protoplasm in the same way that van't Hoff followed the progress of reactions *in vitro*. It therefore becomes possible to apply van't Hoff's methods and formulæ directly to protoplasm in its living and active condition. The following example will suffice to show how this may be accomplished.

The electrical resistance of living tissue of the marine alga *Laminaria* was measured by a method which has been previously described.[1] The tissue had in sea-water a resistance of 980 ohms.[2] On being placed in NaCl .52*M* (which had the same conductivity as sea-water) the resistance fell after 10 minutes to 855 ohms and after 20 minutes to 745 ohms: it continued to fall rapidly and finally became stationary at 320 ohms. This represents the death point. The total change produced by the NaCl was 980–320 = 660 ohms.[3] In order to find out whether this change had been produced in such a way as to correspond to a known type of chemical reaction the amount of change was measured at brief intervals. The results are given in Table I.

TABLE I

t = time in Minutes	Resistance	x = loss of Resistance	$a-x$	$\frac{a}{a-x}$	$\log_{10}\frac{a}{a-x}$	$k=\frac{1}{t}\times\log_{10}\frac{a}{a-x}$
0	980	0	660			
10	855	125	535	1.234	.0913	.00913
20	745	235	425	1.553	.1911	.00955
30	655	325	335	1.970	.2944	.00981
40	590	390	270	2.444	.3881	.00970
50	540	440	220	3.000	.4771	.00954
60	495	485	175	3.771	.5764	.00961
70	465	515	145	4.551	.6581	.00940
80	440	540	120	5.500	.7403	.00925
90	405	575	85	7.765	.8901	.00989
100	395	585	75	8.800	.9444	.00944
110	380	600	60	11.00	1.0414	.00947
120	366	614	46	14.35	1.1568	.00964
130	359	621	39	16.91	1.2281	.00 45
140	351	629	31	21.29	1.3282	.00949
150	345	635	25	26.40	1.4216	.00948
160	339	641	19	34.74	1.5408	.00963
200	320	660	0	dead		.00953 = Average
250	320	660	0	dead		
300	320	660	0	dead		

a = total change = 980–320 = 660 ohms.
Temperature 18.5° C.

According to van't Hoff we can determine from such measurements whether one, two or more substances are taking part in the reaction. If only one substance takes part (or if two substances take part but only one of them changes its concentration noticeably) the reaction is said to be of the first order (monomolecular) and it proceeds according to the formula

$$k = \frac{1}{t}\log\frac{a}{a-x},$$

in which t is the time which has elapsed between the beginning of the reaction and the taking of the measurements, x is the loss in

[1] Science, N. S., 35: 112, 1912.

[2] If left in sea-water this resistance is maintained for a long time.

[3] The fact that this action of NaCl may be antagonized by $CaCl_2$ does not affect the subsequent discussion.

resistance at the time t, a is the total amount of change in resistance when the reaction is completed and k is a constant (called the velocity constant) which indicates the speed of the reaction. If the reaction is of the first order (monomolecular) k should come out constant provided the temperature be kept constant during the reaction.

In this case a, which represents the total amount of change, is $980 - 320 = 660$ ohms, while x represents the loss of resistance after 10, 20, 30 minutes, etc. In the calculations common logarithms have been employed. It will be seen from the table that k is nearly constant: the variations are no greater than are commonly found in measuring chemical reactions in the test tube.[4] It is probable that they would have been smaller if the temperature could have been kept perfectly constant.

The simplest interpretations of this are as follows. We may suppose that the NaCl reacts with some one substance in the protoplasm but that so little of the NaCl is used up that its concentration changes but slightly.[5] It can be shown by analytical methods that the concentration of the NaCl suffers but little change. In all of the experiments more than 1,200 c.c. of NaCl .52*M* were employed to 10 c.c. of tissue.

It should be added that if a series of reactions is involved what we measure is practically the rate of the slowest of the series.

An alternative interpretation is that the loss of resistance is due to the spontaneous change of some one substance in the protoplasm, a process which goes on with extreme slowness until catalyzed by the NaCl. This view is of great interest because it implies that the process of death is always going on even in a healthy and growing cell.

If we suppose the NaCl to act as a catalyzer it may be that the reaction which it accelerates is the hydrolysis of some substance in the protoplasm. This would behave as a reaction of the first order since the concentration of neither the NaCl nor the water would undergo much alteration. The reaction might be compared to the hydrolysis of cane sugar (when catalyzed by acid) which behaves as a reaction of the first order.

On this view death would be due to the hydrolysis of some substance (probably protein) in the protoplasm. There is a variety of evidence that death is accompanied by such hydrolysis.

We should not overlook the possibility that the opposite process (dehydration) would give quite the same result. Death is often accompanied by the coagulation of certain proteins. According to some authors coagulation involves dehydration while according to others it is a process of hydrolysis.[6]

We may now consider other possible suggestions. One is that the progress of the reaction is determined not by the number of substances taking part but by diffusion. The NaCl[5] diffuses inward (and the other salts outward) rapidly at first, then more and more slowly, thus affording a certain likeness to the curve of a reaction of the first order. The incorrectness of this interpretation is shown by a study of the temperature coefficient. The temperature coefficient of diffusion is low, the increase in the rate of diffusion being less than 30 per cent. for an increase of 10° C. The increase in the velocity of the reaction of NaCl with living protoplasm amounts to over 150 per cent. for an increase of 10° C., which

[4] The most constant value of k is obtained when the material is sound and is taken directly from the ocean just before the beginning of the experiment. The temperature should not be allowed to rise much above that at which the plants have been growing. The fronds should be neither too old nor too young, and should not have reproductive organs. Fronds should be selected which have the mechanical properties requisite to cause the disks to lie flat in the apparatus when it is closed, but to separate spontaneously when it is opened. Failure to realize these conditions, as well as other imperfections in technique, may produce irregular fluctuations in the value of k.

[5] This applies as well if we suppose that the NaCl in uniting displaces some other substance (*e. g.*, $CaCl_2$) provided the latter is not allowed to accumulate too much in the solution.

[6] The addition or splitting off of H ions would also behave as a reaction of the first order.

shows clearly that we are dealing with a chemical reaction. We must, therefore, exclude the interpretation that diffusion is the determining factor.[7]

Another suggestion is that the result is due merely to the fact that the majority of the cells are more accessible to the reagent or less resistant to it than the rest, so that more cells are killed in the first minute than in the second and so on. But if this were the case we could not, after a lapse of ten minutes (when the loss of resistance already amounts to 125 ohms), restore tho tissue to its initial resistance by replacing it in sea-water. This can be done and there is no evidence that the tissue is in any way injured by such treatment with NaCl.[8] The same piece of tissue may be treated with NaCl (for five minutes) and replaced in sea-water several times each day for ten days in succession without showing any sign of injury.[9]

This leads us to the following conclusion. Since the effect of NaCl is within wide limits completely reversible, without production of injury, *the conception of the chemical dynamics of living protoplasm here developed applies not only to reactions which produce death but also to reactions which involve no injury and which form a normal part of the activity of the cell.* This conclusion is fully confirmed by experiments with a variety of other substances.

W. J. V. OSTERHOUT

LABORATORY OF PLANT PHYSIOLOGY,
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[7] There are other important reasons opposed to the suggestion that diffusion is the determining factor. One of these is the length of time required for the process. If tissue is transferred from sea-water to sea-water diluted with one or two volumes of distilled water, there is a change of resistance which continues until equilibrium has been restored by diffusion. This process at 18° C. does not take more than ten minutes, whereas nearly three hours would be required for the reaction with NaCl which we have been measuring.

[8] This and other experiments show that the increase in the conductivity of the protoplasm is not to be attributed to an increase in the concentration of electrolytes within the cell but rather to a decrease in the viscosity of the protoplasm (or to an increase in some other factor which facilitates the passage of ions).

[9] SCIENCE, N. S., 36: 350, 1912.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION H—ANTHROPOLOGY AND PSYCHOLOGY

AT the recent annual meeting of the American Association for the Advancement of Science held at Atlanta, Georgia, December 29 to January 2, Section H—Anthropology and Psychology—participated in four sessions. Tuesday afternoon was devotod to a "general interest" session at which Professors Max Meyer and Lightner Witmer spoke. Wednesday morning was given over to a joint meeting with the Southern Society for Philosophy and Psychology; Thursday morning to a joint session with Section L—Education, and Thursday afternoon to a joint session of all three of these organizations. In all some twenty-two papers were presented.

The following officers were elected: *Vice-president of the Association and Chairman of the Section*, Dr. Clark Wissler, of the American Museum of Natural History; *Member of the Sectional Committee* (to succeed Dr. G. A. Dorsey), Professor Lightner Witmer, of the University of Pennsylvania; *Member of the Council*, Professor Max Meyer, of the University of Missouri; *Member of the General Committee*, Professor L. R. Geissler, of the University of Georgia.

The following twelve papers were presented under the auspices of Section H:

The Present Problems of Physiological Psychology: MAX MEYER.

Psychologists generally are beginning to realize that the study of consciousness is only a secondary, an auxiliary branch of psychology. But it is a mistake to think that psychology can be defined simply as the study of behavior. The study of plant behavior is the business of the botanist. Nothing forbids, of course, interest in plant behavior on the part of the psychologist save common sense, which would call a man a botanist if he is more interested in plant behavior than in human life. In a similar way the study of animal behavior must be regarded as primarily the task of the zoologist. And the study of human behavior seems to be largely the province of the sociologist (including under "sociology" as a special branch the science of education). Is then

nothing left for the psychologist as his proper field? My answer is that it is the psychologist's business to make comprehensible that link which is interposed between our sensory surfaces and our muscles, the function of the nervous system. Apparently, this demand is supplied by a scientist who, again, is not the psychologist—by the physiologist. As a matter of fact, however, a text-book on the physiology of the nervous system, even such as Sherrington's or Loeb's, would not suit the needs of a college class in psychology. I should say, therefore, that the psychologist's task consists in making comprehensible the function of the nervous system as the chief determiner of all those varied forms of human behavior which we find described in a good novel, in the drama, in biography, in history, in the newspaper. In order to illustrate this task, a number of typical problems were discussed and solutions proposed.

Children with Mental Defects Distinguished from Mentally Defective Children: LIGHTNER WITMER.

"Were society so organized that success in life in every sphere of activity were dependent upon a good enough ear to turn a tune, many persons who are now doing useful work in the world would have to be relegated to the class of imbeciles." Several cases were reported, among them the case of a boy who at fourteen years, although he was normal in appearance and behavior and had been attending school regularly, was at the educational stage of a child of seven. He was unable to read for himself, for pleasure or profit, and his spelling was as deficient as his reading. When he wrote a letter it was impossible to make out his meaning without knowing what he had intended to say. Careful examination showed that the boy was suffering from a language defect, psychologically a defect of memory. There was both a weakness in retaining new impressions and a weakness in the recall of impressions which had been received and partially retained. He was word deaf as well as word blind, or, to put it scientifically, he was a case of congenital aphasia. "Congential aphasia is a more serious defect to the individual than the lack of an ear for music, because of the social and industrial importance of speech; perhaps also because a certain measure of language development is essential for accurate thinking. . . . I regard the child, for that matter the adult also, as composed of a number of traits, some of them assets if they favor normal mental development and success in adult life; some of them defects if they provoke retardation, arrested development, delinquency and crime. There is no so-called normal person who does not possess some defects along with his assets. The type of child in whom I am especially interested and for whom I organized and am directing the work of the psychological clinic at the University of Pennsylvania, is the child who has so many and such severe mental defects as seriously to interfere with normal development in the home and in the school and to prognosticate his arrival at adult age arrested in mental and moral development. Because a child has one or a few mental defects, we must not characterize him as mentally defective. . . . A strictly scientific nomenclature will dispense with the term 'mentally defective,' as failing to characterize with sufficient definiteness the class of children under consideration. What characterizes 'mentally defective' children is not that they are mentally defective, for other children, in fact all children, are mentally defective, but that they are so defective mentally as to be socially unfit. For the term 'mentally defective' I would therefore propose substituting the term 'socially unfit' or 'socially defective.'"

Published in *The Psychological Clinic*, Vol. VII., No. 7, December 15, 1913.

Some Fundamental Concepts in Social Psychology: L. R. GEISSLER. (By title.)

Correlation of Mental and Physical Measurement: JASPER C. BARNES.

The correlations described in this paper are based upon the physical measurements of one hundred students, members of the psychology class in Maryville College, during the year of 1912–13 and the fall term of 1913. The list includes fifty young men and fifty young women representing all of the four college classes and twenty different states. The average age of the young men was 21.7 years, while the average age of the young ladies was 21.3 years. The youngest in each case was 17. The oldest young man was 26, and of the young ladies 31. The mental measurements are in terms of grades received by the students in their various studies, and hence are not mental measurements in the laboratory sense at all. The physical measurements were five: height, weight, vital capacity, length and width of head. The apparatus used was the stadiometer, anthropometric scales, wet-spirometer and head calipers.

According to the method of group comparison there seems to be very little relation between height and scholarship, or weight and scholarship. But between the vital capacity and mental abil-

ity there appears to be some correlation by the method of comparison, yet when computed by Pearson method the index of correlation is very small. The coefficients of correlation calculated by the Pearson method are as follows:

	Men	Women
Weight and class standing......	.056	.052
Height and class standing......	.023	.216
Vital capacity and class stdg....	.085	.245
Cephalic index and class stdg....	—.033	—.151

In summing up the foregoing, it appears that the measurements in this series have little interdependence.

The index of correlation except in the case of the vital capacity of women, is a negligible quantity. However, the number of cases is too small in our investigation to justify the statement of any general conclusion or law. It may be said, nevertheless, in the hundred cases studied, there seems to be little, if any, correlation between mental ability, as shown by class standing of college students, and height, weight, lung capacity and cephalic index.

The Causes of the Declining Birth-rate: J. McKeen Cattell.

The completed family of contemporary scientific men is about 2, the surviving family about 1.8 and the number of surviving children for each scientific man about 1.6. Twenty-two per cent. of the families are childless; only one family in seventy-five is larger than six. The same conditions obtain for other college graduates. The speaker discussed the biological causes through which the fertility of a woman has been limited to an average of about twelve children, the social causes which lead about one half of all women of child-bearing age to remain unmarried, and the pathological and psychological causes which give the present family of two or three children. Answers had been received from 461 leading scientific men giving the causes which led to the limitation in the size of their families. One hundred and seventy-six were not voluntarily limited, while 285 were so limited, the cause of the voluntary limitation being health in 133 cases, expense in 98 cases and various other reasons in 54 cases. Childlessness was involuntary in two thirds of the cases. In the standardized family of two the condition is desired in six cases out of seven. In over one third of the families the limitation was involuntary, due to infertility and other pathological causes, but if these had not obtained, voluntary limitation would have occurred in nearly all or perhaps in all cases.

On the Effect of Adaptation on the Temperature Difference Limen: Edwina Abbott.

The effect of adaptation to different temperatures on the difference limen for 40° C., 37.5° C., 35° C., 32.5° C., 30° C., 27.5° C., 25° C., 22.5° C., 20° C. and 17.5° C. was determined. Water was used as the adaptation medium and was kept at any desired temperature by means of an electric heater controlled by an electric thermostat. The fingers of both hands of the subject were adapted to a certain temperature as far as the second joint and when adaptation was complete the fingers were raised and those of one hand dipped into water of the standard temperature and those of the other hand into water of the variable temperature for the difference limen test. The method of right and wrong cases was used in determining the limen and the fingers readapted before each test. Four trained subjects were used.

The results indicate that: (1) The difference limen for a given temperature after a given adaptation temperature is relatively constant for a given individual; (2) the absolute amount of the difference limen under such circumstances differs for individuals, but the relation between the limina for different temperatures after any given adaptation temperature remains the same for different individuals; (3) the point of greatest sensitivity to difference lies at 32.5° C.; (4) the preceding adaptation temperature affects the difference limen for a given temperature, the difference limen, in general, increasing as the adaptation temperature varies from the standard temperature; except for 32.5° C. where the difference limen remains constant under all conditions of adaptation.

Eventually to appear in the *Psychological Review*, Monograph Series.

A Study of the Behavior of the Chick: Ada Hart Arlitt.

In February of 1913 work suggested by that of Feré on the effect of alcohol on the physiological development of the chick was undertaken in the biological laboratory of Newcomb College. It was found possible to raise healthy chicks from eggs which had been subjected to alcoholic treatment, but the behavior of these chicks differed from that of normal chicks hatched in the same incubator at the same time.

The reactions to light and the pecking and drinking reactions of the abnormal chicks differed but little from those of normal chicks.

Abnormal and normal chicks were placed on stands from 10.7 cm. to 179 cm. above the box in which they were kept and the height at which they refused to jump recorded. The abnormal chicks jumped from greater heights.

To determine the difference in rapidity of learning three mazes were used, one a straight path blind at one end, one a simple choice maze with the exit on the left side, the third the Yerkes apparatus.

The chicks were given ten trials each in each of the first two mazes and the time taken to find the exit recorded. Abnormal chicks learned their way out of the first maze almost as swiftly as normal chicks, but learned their way out of the second much more slowly, making many wrong choices. Two failed to learn the way out.

With the Yerkes maze the number of trials taken before the chick made ten consecutive right choices was recorded. The exit was on the right side. The normal chicks learned the way to the exit in 8 trials, the abnormal in from 23 to 45 trials.

Two Factors which Influence Economical Learning: EDWARD K. STRONG, JR.

The paper presented the results of a number of experiments in the field of advertising and discussed their bearing upon studies that have been made in the field of economical learning.

The general conclusions were as follows: (1) Repetitions of advertisements a few minutes apart or a week apart are about equal in efficiency when tested four months later, but both such intervals are superior to repetitions a month apart. On the basis of all the work in this field, it would seem that the optimum interval for repetition is one day. (2) The more impressions made at one time, the less is the permanent retention of any one of them. This is probably due to the effect of retroactive inhibition. (3) In any situation when both length of interval and the number of impressions to be made at any one time are concerned, it should be borne in mind that the second factor is far more important than the first. This means that further work should be directed more particularly to a better understanding of how many impressions can be made to advantage at any one time, rather than to the proper interval of time between their successive presentations.

Published in the *Journal of Philosophy, Psychology and Scientific Methods*, Vol. XI., No. 5, February 26, 1914.

Psychological Characteristics of the African Negro: JEROME DOWD.

Professor Dowd divided Africa into economic zones, and contrasted the characteristics of the people of each zone.

"The instinct of flight is very pronounced in the banana zone. Nature is here manifested in a very violent form—exciting terror and gross superstitions. It is a zone of idols, fetichism, witchcraft and the magic-doctor. In the agricultural zones nature is less antagonistic, and the struggle for existence more severe, requiring more reason and courage. Here the emotion of fear is less pronounced—the number of idols diminishes, and the magic-doctor uses less hocus pocus and more medical art. In the cattle zone, where nature is still less violent and terrifying and the climate and other conditions more conducive to action, we observe still less fear among the people, less use of idols, witchcraft and magic-doctors.

"The instinct of pugnacity is weak in the banana zone because of the intensity of the feeling of fear. It is more pronounced in the agricultural zones, and very much so in the pastoral zones where the conditions provoke chronic warfare. This instinct is of great value to any race—since, under peaceful conditions, it is carried over into all lines of activity. Instead of the war of fire and sword, we have the war of tools, machinery, commodities and ideas. From the games played by children and adults up to the rivalry of nations for intellectual and moral supremacy we see the play of this primitive instinct. The nations that now occupy the highest rank in the industrial rank in intellectual and moral development are precisely those which have gone through the fiercest and most prolonged era of warfare.

"The gregarious instinct is remarkably developed in the central regions of Africa where the bounty of nature permits of the living together of large groups. It is not quite so well developed in the other zones, although it is everywhere very characteristic of the African Negro. In the lower stages of society this instinct serves the useful purpose of insuring to aggregations of people the development of laws and institutions. McDougall believes that this instinct is less important for civilized people and often produces anomalous and even injurious social consequences in large cities. According to Giddings and McDougall, this instinct is due to consciousness of kind. I believe, however, that people are attracted to each other by unlikeness, and the so-called instinct of gre-

gariousness is nothing but the expression of the instincts of fear and curiosity."

Reason, imagination, inhibition and other characteristics were discussed.

A Comparison of White and Colored Children Measured by the Binet Scale of Intelligence: JOSIAH MORSE.

Two hundred and twenty-five white and one hundred and twenty-five colored children in the public schools of Columbia, S. C., were tested; ages ranging from six to twelve, inclusive. Results: The number of white children testing *at age* is decidedly larger than any other group, whereas for the colored children the largest group is the one testing one year below age. In the satisfactory group there is a difference of nearly 15 per cent. between the white and colored; nearly three times as many colored are more than a year backward, and less than one per cent. are more than a year advanced.

The picture tests, those relating to time and money, distinguishing between morning and afternoon, enumerating the months, counting stamps and making change, the drawing tests, both copying and reproducing from memory, were all too difficult. The answers to the questions of comprehension, to the absurd statements and to the problems of various facts, were often absurd or senseless; the best replies, however, compare favorably with those of the white children. The definitions were often not better than terms of use, and frequently stated in the language of a younger child.

Compared with the white, the colored children excelled in rote memory, *e. g.*, in counting, repeating digits—though not one was able to repeat 26 syllables—naming words, making rhymes, and in time orientation. They are inferior in esthetic judgment, observation, reasoning, motor control, logical memory, use of words, resistance to suggestion, and in orientation or adjustment to the institutions and complexities of civilized society.

A rough classification into three groups, according to color—dark, medium, light—showed that the darkest children are more nearly normal, the lightest show the greatest variation, both above and below normal.

The paper appeared in the January nnmber of *Popular Science Monthly*, Vol. LXXXIV, No. 1, January, 1914.

A General Intelligence Test: L. R. GEISSLER.

Minor Studies in Learning and Relearning: DAVID SPENCE HILL.

The studies presented were from the standpoint of an instructor in educational psychology for college classes, and illustrate useful methods of individual and class experimentation. The studies consist of three series. The first is descriptive of material for and uses of mirror-drawing. One subject practised drawing stars for forty-eight days. Three years afterward the trials were resumed, and it was found that in about three trials the former speed and accuracy were attained. Analysis of the relearning does not show evidence that "the mind continues its activity for a time in the furtherance of a learning process after practise and study have ceased," as suggested in the similar experiment of Swift.

In the mirror-drawing experiment, by initial and terminal tests before and after the above practise, an interesting demonstration was made of the regulation of transfer effect, both to right and left hands. This was accomplished by the use of slightly dissimilar geometrical figures, by the use of which there were found fairly consistent differences in net results of improvement.

The second study is a class experiment employing substitution tests. A group of ten students participated during twelve days. A presentation of the problems of intervals of study, the method of equal groups, the question of individual differences before, during, and after practise is included.

The third series consisted of cancellation experiments the object of which was to illustrate a convenient form of A-test suitable for group or individual use. In constructing the form, twenty-six marbles were marked with the letters of the alphabet, shaken in a small basket and thereupon a marble was withdrawn. After the letter was written down another mixing and withdrawal was made, and finally the MS. thus constructed was printed by a linotype. This method of distributing the twenty-six letters, although laborious, secured for practical purposes one hundred alphabets arranged in chance order. A group test during fourteen days was made upon the effect of practise in making A's and concerning the transfer of the improved capacity to marking words containing e and r, from a Latin text. The results are not inconsistent with those of Thorndike.

The paper will appear in the *Journal of Educational Psychology*.

EDWARD K. STRONG, JR.,
Acting Secretary, Section H

SCIENCE

FRIDAY, APRIL 17, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE MECHANICAL, THE HISTORICAL AND THE STATISTICAL

I. PRACTICAL PURPOSE OF THIS MEETING

THIS meeting is the outcome of conversations which resulted from the recent book of Dr. Henderson on "The Fitness of the Environment." Yet this company is not called for the sake of discussing, on the present occasion, that book, or any of the scientific problems which it more directly considers. The connection, then, between Dr. Henderson's book and this evening's undertaking needs some explanation. As you know from the wording of the call to which you have so kindly responded, one principal purpose which I have in mind as I address you is practical. I shall ask you, before the evening is done, to give some thought to the question: Is it advisable for us to meet again occasionally, as opportunity offers, in order to discuss some questions of common scientific interest. You represent various departments of research. Is it worth while for you, or for some of you, at your own pleasure, to come together in such a way as the present one, in order to take counsel about different problems which belong, not only to a single science, and not only to some special group of sciences, but also to the realm which is common to a decidedly wide and varied range of scientific inquiries?

My part in this evening's discussion is determined by this practical question. I can not come here as a representative of any one department of research in natural science. I am limited in my present undertaking to such an appeal as a student of philosophy may have a right to address to

a company of scientific men, when he wishes to ask them a practical question whose answer concerns them all.

The only justification which I have for addressing you is that the habits of a student of philosophy, and, in particular, of a student of logic, make him sensitive to the value of a comparative scrutiny of the methods, the conceptions and the problems of various sciences.

If the main topic of the evening is a question relating to the practical value of some new mode of cooperation, in which a number of representatives of different departments of scientific research are to be asked to take part, the student of philosophy may possibly serve as a sort of traveling agent. For the kind of cooperation to which I have been asked to invite your attention would involve, if it succeeded, certain journeys which some of you might thereby be induced to make into the provinces of your colleagues. Widely traveled though all of you are, these journeys may lead occasionally to novel incidents, and may please or arouse you in new ways. My business, I say, is to act this evening merely as such a tourist agent, describing and praising as I can the new kind and combination of journeys to which my agency proposes to invite you.

Philosophy itself, in so far as it is a legitimate calling at all, may in fact be compared to a sort of Cook's bureau. Its servants are taught to speak various languages—all of them ill—and to know little of the inner life of the numerous foreign lands to which they guide the feet, or check the luggage of their fellow-men.

But if new comparative studies of the ideas of various and widely sundered provinces of research are to be carried out at all, Cook's agents, tedious as they often are, have their part to play. Regard me, then, if you wish to vary the name, as representing this evening some bureau of university travel.

II. PRELIMINARY VIEW OF THE THEORETICAL PROBLEM OF THIS PAPER

Speaking seriously, let me say that my task, upon its theoretical side, involves undertaking to present to you, in a perspective which may prove to be not wholly familiar, an outline sketch of certain conceptions and methods which actually belong to widely various sciences. These conceptions and methods in some measure concern you all, and, in our day, they are undergoing various changes, and are being applied to new problems.

The problems of each science are its own affair; but they also concern the whole body of scientific workers. To look over a somewhat wide range of scientific work, not for the sake of contributing to the researches of any one special science or group of special sciences, but for the sake of studying for their own sake some of the most general ideas and methods that are used by various scientific workers—this is, at the present time, a legitimate undertaking, and, in view of what has already been done, and is now under way, is not a hopeless undertaking.

The perspective in which such a study may place the problems of other people may help them to understand one another better. My task, on its theoretical side, is limited this evening to a few such general methodological remarks. These remarks may then lead us back to our practical question.

III. THE PROBLEM OF VITALISM

The name vitalism is often given to those doctrines which have used the hypothesis that the phenomena of living organisms are due to some process which is essentially identical in its nature with the process ex-

emplified by our own conscious voluntary activities. We deliberate, plan and choose. It seems to us as if certain things and occurrences in the world were due to these our plans and choices, and are different from what they would be were our will not a factor in the world-process. On the other hand, some things and events in the natural world—notably the recurrent movements of the heavenly bodies, and the processes which attend the workings of machines, seem to us to be, in some or in many respects essentially different from the processes which result from our plans, our choices and our voluntary deeds. What is called a mechanical theory of nature, or, more generally still, materialism, undertakes to account for the vital processes, for the activities of organisms, by supposing that they too are not essentially different from the other material processes, and that they really exemplify the same natural laws which the movements of the heavenly bodies and the workings of machines illustrate.

The contrast between vitalism and materialism is, in the history of science and of philosophy, very ancient. The Greeks began with doctrines which were, in a somewhat confused way, both materialistic and vitalistic. The natural world was viewed as, in one of its aspects, a sort of machine, a chariot whose mechanical movement was an essential feature of its very being. The natural world was also regarded as through and through alive—a world of love and strife, of mixing and of sundering, of wisdom and of something resembling contrivance.

To this early Greek vitalism, which had various forms, the materialism of Democritus opposed a mechanical theory of nature which was much more ingenious and considerate than were the earliest forms in which the machine-like aspect of nature was described. On the whole, however, vitalism, the doctrine that nature acts not in vain, but in an essentially planful and designing way, was predominant in Greek thought.

The greatest Greek vitalist was Aristotle. Materialism remained in the background of ancient thought, and was destined to be revived, and to take on the form of the modern mechanical theory of nature, only after the beginnings of the new science in the seventeenth century of our era.

These ancient problems as to whether nature is rather a mechanism or an expression of something which essentially involves or resembles wisdom and contrivance, are certainly not questions which belong to any one natural science or group of natural sciences. From time to time, however, they come nearer to the surface of popular or of scientific discussion. The present is a moment when a certain interest in various forms of vitalism has once more become prominent in the discussions not only of philosophers and of leaders in popular inquiry, but of some professional students of the natural sciences of life as well.

I do not know how far it will prove to be interesting or profitable for you, as scientific men, to discuss, in your future meetings, if you have any future meetings, problems directly connected with vitalism, or with its old opponent, the mechanistic theory of the nature of life. I know only that when we mention such problems we call attention to one of the ancient boundary lines, or, as one may say, to one of the beaches where, in the realms of inquiry, sea and land come face to face with each other; so that two widely contrasting realms of nature here seem to clash. Here, then, the waves of experience tumble, and

the tides of opinion rise and fall. Here, then, for that very reason, and especially at this very time, new discoveries are likely to be made in especially impressive ways.

If you are to compare notes, it will therefore not be surprising to find that questions about the relations, the contrasts and the connections of life and of mechanism will become prominent in your discussions. My own preliminary remarks on the classification of scientific methods may well be guided, then, by some interest in the scientific processes which go on upon this old boundary line—this sea-beach—of opinion and of investigation, where the vast and doubtful seas of inquiry into the phenomena of life encounter, as it were, the firm land where the mechanical view of nature finds its best known illustrations.

IV. THE VITALISM OF ARISTOTLE

It will help us in our survey of our problems about the contrasting ideas and methods followed by the inorganic sciences on the one hand and the sciences of life on the other hand, if we next say a word about one aspect of Greek vitalism which is frequently neglected.

Life-processes in general resemble our own human voluntary processes, as we have said, in so far as any living organism seems to us as if it were guided by some sort of design, and as if, through a kind of wisdom or contrivance it adjusted means to ends. To say this, however, and even to believe that this seeming is well founded, and that, in some wise living nature really is planful, and does embody something of the nature of will, or of purpose—to assert all this is not yet to decide how close the real resemblance is between the teleology of nature and the choices and contrivances of a man who is planning and who is exerting his will.

As a fact there have been many vitalists who thought nature, and in particular organic nature, to be purposive, but who did not believe that nature is clearly aware of her own designs.

There have been many vitalists who conceived of nature as in some sense even divine in its skill, but who did not accept theism either in its primitive or in its more cultivated forms. The design argument in its later theological formulations is not any classic argument for vitalism. All this becomes manifest if you look for a moment at Greek vitalism, and, in particular, at the vitalism of Aristotle.

The Greek vitalists well knew that nature, however wise she seems to be, does not show signs of deliberating like an architect before he builds a house, or of piecing together her works as a carpenter devises a chest or a bed. For the Greek vitalist, and, in particular, for Aristotle, nature fashions, but not as a human mechanic fashions—piecemeal and by trial and error.

Nature's skill is (so such vitalists think) more like that of a creative artist, who does not pause to know how he creates. If ideas inspire the artist, he does not reflect upon what they are. Just so, while the being whom Aristotle calls God, who is conceived to exist quite apart from the world, is indeed self-knowing and is wisely self-observant, Aristotle's God is not the God of the later design argument. For he neither creates nor fashions the natural world. Nature, in Aristotle's opinion, is not God, and is not God's handiwork, but is, with a certain instinctive and unconscious wisdom, a sort of artistic imitator of God's wisdom. And this natural process of imitating the divine perfection by quickening a material world with a tendency to be fashioned after

a divine pattern—this process constitutes the life of the natural world.

The designs which nature expresses are therefore for Greek vitalism not the conscious designs of anybody—either God or man. They are the creative tendencies which embody themselves in the material world, by a process which we can best compare with the workings of instinct or of genius.

Now modern vitalism is far away from its Greek forerunners, but whenever, for any reason, vitalism becomes afresh interesting to any group either of philosophers or of scientific workers, it is well to remember that the contrast and the conflict between a mechanical view of nature and a vitalistic view has hardly ever been limited to the decidedly special and artificial antithesis between blind mechanism, on the one hand, and conscious or deliberative design, on the other hand. For even our human art is, as Aristotle remarks, partly guided by a skill which is not conscious and is not deliberate. That which, in recent years, Bergson has called élan vital—the creative vital power, was well known, in their own way, to the Greeks.

Different as Bergson's vitalism is from that of Aristotle, the ancient view and Bergson's vitalism have in common the belief that life means a process of which the instinctive skill and the artistic genius of man give examples. The problem of vitalism is always the problem as to how such unconscious skill, such undeliberative art, is made possible.

And so, even in this sketch of the varieties of scientific method, I shall in passing name to you one way in which some of the newest hypotheses may enable us to face, and perhaps in some measure to clarify, the problem as to how this stimulation of conscious designs by processes which are themselves unconsciously or, so to speak, blindly wise, is a possibility in the natural world.

V. THREE TYPES OF KNOWLEDGE: THE HISTORICAL, THE MECHANICAL AND THE STATISTICAL

So much must suffice as an introductory word regarding those problems about vitalism and mechanism which have recently been revived, and have brought us together. Herewith we are ready to proceed to our classification of the conceptions and the methods which have been and which may be used in dealing with such a range of problems as is this.

The attempt to sketch in a preliminary way what these conceptions and methods are can be preserved, I think, from vagueness, if I begin by using the guidance of a man of whom you all are accustomed to think as a true natural philosopher—one who was possessed of a very exact sort of scientific knowledge, and who was a great scientific discoverer. He was also very fond of a comparative study whereby he lighted up his own researches through thoughts that came to him from far-off fields. I refer to Clerk Maxwell. In a paper whereof some fragments are printed in his biography, as well as in various remarks in his published writings, Clerk Maxwell more than once used the classification of scientific knowledge which I shall here employ for our present purpose. Natural science, in so far as it studies the processes of the natural world, has three kinds of objects with which it deals. And it adjusts itself to these three kinds of objects by methods which, in each of the three fields thus defined, vary widely from one another; while in each of the three fields both the conceptions and the methods used have much in common, and much too whereby each of the three fields differs from the others. The three sorts of ob-

jects are: (1) Historical objects, (2) mechanisms, and (3) statistically defined assemblages. The three sorts of methods are: The historical, the mechanical and the statistical.

Clerk Maxwell's few but momentous observations upon these three fields of scientific knowledge have a beautiful brevity, and show a fairly poetical skill of imagination whereby he finds and expresses his illustrations both of scientific ideas and of methods. I can not follow the master in his own skill. And I shall be unable to use his language. I must portray his classification in my own way, and must use my own illustrations.

If you wish to come into closer touch with this aspect of the master's thought, you may use the concluding passage of his famous elementary treatise on the "Theory of Heat," and several remarks in his article on "Atoms" in the ninth edition of the Encyclopedia Britannica. In addition I may refer you to the citations made by Theodore Merz in the eleventh chapter of Volume II. of his "History of European Thought in the Nineteenth Century" (pp. 599, 601 and 603).

Let me briefly review, with a few illustrations, this classification of the three fields and the three methods of natural science.

Science deals either with substantial things (such as atoms or organisms) or else with events. Let us confine ourselves here to the works of science in its dealings with natural events and processes. Science deals with the historical when its objects are individual events or complexes of events, such as is a single solar eclipse, or such as is the birth or the death of this man, or the performance of just this act of choice by this individual voluntary agent.

Science deals with the mechanical when its objects are the invariant laws to which all the individual events of some field of inquiry are subject, and when such invariant laws actually exist, and can be used to compute and to predict actual events. Thus, if the acceleration which every individual body belonging to a system of material bodies undergoes depends at every instant, in an invariant way, upon the spatial configuration of the system of bodies at just that moment, the system is a mechanical system—such, for instance, as a system of bodies moving in accordance with the Newtonian law of gravitation.

Science deals, in the third place, with the statistical, when it studies the averages in terms of which aggregates or collections of events can be characterized, and when it considers not the invariant laws, but the always variable possibilities that these averages will be subject to certain uniformities, and will undergo definable changes.

In brief, the object of historical knowledge is the single event, occurring, in the ideally simple case, to an individual thing. A free-will act or an observed eclipse serves as an example. The object of mechanical knowledge is the unchanging natural law under which every event of some type can be subsumed. Sometimes the object of mechanical science may be an individual event, but only in so far as, like the eclipse, it can be predicted by means of such an invariant law. The object of statistical knowledge is not the single event and is not the invariant law, but is the relatively uniform behavior of some average constitution, belonging to an aggregate of things and events, and the probability that this average behavior will remain, within limits, approximately, although always imperfectly uniform.

VI. Applications of this Classification

In view of this classification of the objects of scientific knowledge, you may see

at once that the issues between such doctrines as vitalism and a mechanistic account of nature appear, from the point of view of Maxwell's classification, in a somewhat unfamiliar perspective. For one need no longer merely contrast two views, the mechanical and the vitalistic. One now has a third and a mediating point of view to compare with both of them. The result is instructive.

Vitalism, whatever else it involves, always makes prominent some aspect of nature, and in particular some aspect of organic nature, such that this aspect is supposed to be, in some individual case, strictly historical. If an organism is due to a purposive process, if the reactions of an organism are, in any instance, events of the nature of conscious or of subconscious deeds—then something unique, historical and novel occurs whenever one of these vital processes is exemplified by an individual event.

On the other hand, if the mechanistic view of nature can exhaustively express the real facts, then the only natural events are of the type which the eclipses exemplify. The single events are, so to speak, points on a curve, selections from an ideal continuum whose constitution is definable in terms of an invariant differential equation.

But the third or statistical mode of viewing nature takes account of another aspect of the processes of nature. The world of the statistical view still contains events supposed to be unique and individual; but from the statistical point of view the main interest lies no longer in each event as it occurs, nor yet in its unique character. The statistical interest is directly concerned with a set or aggregate of events, with a discrete multitude of occurrences. These occurrences may prove to be examples of law. The statistical view is deeply interested in finding that they are examples of law. But the law for which the statistical method seeks is no longer a law that is ideally statable in terms of an invariant differential equation or in terms of any other timeless invariant. When found, the statistical law is an account of a collection of facts in terms of averages involving many events.

This account takes some such form as saying: "The average magnitude or velocity or size or range of the events of the class C is approximately V." Or, again, the statistical view succeeds when we can say: "A proportion which is approximately p of the events of the class a have the character b." Or finally, one expresses the statistical view when one is able to assert: "There is a probability q that c differs from d by not more than such and such an amount,—say X." All such generalizations, where the objects in question are living organisms, relate to events, but neither to merely historical single events nor to events subject to fixed laws. The statistical laws are probable and approximate laws about numbers of events.

Laws and probabilities, stated in some such form as the one just suggested, constitute the characteristic formulas of the statistical view of nature.

It is easy to illustrate how the statistical view contrasts with both the mechanical and the historical point of view by considering how each point of view applies to an event such as is expressed by the assertion: "A killed B."

For a strictly historical point of view this event, this homicide, is an unique occurrence—possibly a free-will act. It falls under moral and criminal laws, but these relate only to its value and its legal consequences. The interest of the case for a judge or a jury lies in its novelty—and in its uniqueness. For a strictly mechanical

view of things the killing resembles an eclipse. Unique as it is, it is supposed to have been essentially predictable. Perhaps if you had known the precise configuration and the accelerations of all the physical particles in the world at some appropriate moment, then this killing could have been calculated in advance. It is a mere case of a law—an eclipse, so to speak, of some sun—a point on some curve.

But for a statistical view the single killing of *B* by *A* is an event against which an insurance provision could have been made in advance—not because any mortal could have predicted whether or no *A* would kill *B*, but because the death-rate of men of *B*'s age and occupation can be statistically known with approximate and probable accuracy, so as to make a policy insuring *B*'s life a contract whose value is calculable, not on mechanical but upon statistical grounds.

Now you will easily recognize that the actual knowledge of vital phenomena which science possesses is, in the main, a statistical knowledge. It is the sort of knowledge which the mortality tables of the insurance companies exemplify. We know little of the history of individual organisms, and less of their mechanism, but we can and do study the statistics of groups of organisms. In such statistical terms heredity and variation are now constantly investigated. In such terms growth and disease, as well as death, economic prosperity and social transformations, financial and political processes, the geographical distribution of organisms and the gradual accumulation and change of the material as well as the mental products of civilization—in such statistical terms, I say, all such things come to be the objects of scientific description and explanation. To give an account of the special phenomena of life in terms of mechanism remains in practise a remote ideal, despite all the proofs that the vital processes, being subject to physical and chemical laws, must be, in some sense, if not wholly, then very largely mechanical in their nature. Life may be a case of mechanism; but its phenomena are best known to science in terms of statistical averages, of laws which hold approximately true regarding these averages, and of probabilities which are definable in such terms as are used when the insurance value of a life-policy is computed. The logic of the insurance actuary is essentially the same as the logic which is consciously or unconsciously used in dealing with all forms and grades of vital processes.

This general rule regarding the methods of the sciences of life is well known to you. For it is also known that, just as a mechanical theory of the details of the phenomena of life still remains a remote ideal, so too an historical knowledge of the individual events of the life of an organism is something which may possess upon occasion great moral or social or perhaps clinical interest, but can occupy but a part, and usually a very small part, of the interest of the sciences of life.

Into the study of human history itself, devoted as such a study naturally is to the sequences of individual events, natural science enters in so far as something of the nature of statistical knowledge is acquired. And therefore the use of deliberately statistical methods in historical study, the use which Dr. Woods has recently proposed—such a use, I say, is in principle nothing essentially opposed to methods long since inexactly and unconsciously employed. For the historiometry of Dr. Woods is in principle a legitimate extension and a logically legitimate refinement of the long since well-known disposition to explain human history in terms of "historical tendencies" and of "historical forces."

In fact, the term *tendency* is, in every exact usage which you can give it, an essentially statistical term. To say that *a* has a tendency to lead to *b* is to declare that a more or less certainly and definitely known proportion of events of the class *a* are followed by events of the class *b*.

To introduce statistics into historical study is simply to try to make some such assertions about tendencies exact.

The constant extension of the use of statistical methods in all the sciences of life is something as familiar as it is momentous. Its very familiarity, in fact, tends to blind the minds of many to its real importance. In truth, the statistical view of nature has a logic of its own. Its three fundamental conceptions, that of an average, that of approximation and that of probability, are indeed not the only fundamental categories of our thought, but they are conceptions which go down to the very roots of our own intelligence as well as of our voluntary activity. It seems increasingly plausible to assert that these three conceptions, while they certainly have their special province, still, within that province go down to the roots of that nature of things which our sciences are studying. At all events, I find it hard to exaggerate the importance of those methods and of those ideas of natural science which are definable in terms of approximation and of probability, in the modern sense of those terms.

When Clerk Maxwell made his threefold classification of scientific methods, he did so with his eyes well open to the fact that by the statistical view of nature, and by statistical methods in science he meant something much wider and deeper than is the mere commonplace that statistical tables can be made by the census bureaus, and can be used by the insurance companies, or applied to the discovering of various special laws of nature. Let me remind you of what Maxwell had in mind.

VII. The Statistical View in Physics

Clerk Maxwell was a physicist. His greatest treatise was that upon electricity and magnetism. The theory of electricity and magnetism follows methods which illustrate the mechanistic way of dealing with the problems of nature. Maxwell defined a system of differential equations in terms of which certain elementary electromagnetic processes can be expressed. Assuming these equations to be true, one can compute the consequences of one's hypotheses, as Newton computed the consequences of supposing the law of the inverse squares to be true for a field of gravitative force. One can then compare the computed results with experience, and upon such computation and comparison with experiment one's method in this case depends. Such is an example of the essentially mechanical view of nature.

But Clerk Maxwell, working as he did at a time when the general theory of energy was in its period of most rapid development, was not content to confine himself to problems of the type of the theory of electricity. He also had his attention especially directed to those physical processes which are illustrated by the diffusion of gases, by the irreversible tendency of energy to pass over from available to unavailable forms, and by various analogous phenomena which can not be expressed in terms of the classic types of mechanical theories.

Following the initiative of Clausius, but developing along lines of his own, Maxwell thereupon worked out his kinetic theory of gases. It is that theory of which he is thinking when he distinguishes the statistical way of viewing nature both from the historical and from the mechanical view.

In fact, when the kinetic theory of gases first defines its swarms of molecules, with their countless paths and collisions, it appears to be viewing a gas simply as a complex mechanism; and in certain respects this seeming is well founded. But the logic of the theory of probabilities, which the kinetic theory uses in deducing the physical properties of gases from the statistical averages of collisions and free paths of the hypothetical molecules, is no longer reducible to the logic of mechanics. For the velocity, the path, and the collision of each individual molecule are all indifferent facts for this kinetic theory of gases; which devotes itself to the study of probabilities and of tendencies. And its methods are in part those which the procedure of the insurance actuaries exemplifies. The logic in question is one which in some respects still needs further elucidation. For even up to the present time the logic of the theory of probabilities is a controverted topic. But there are a few features of the situation about which nobody who looks carefully into the subject can retain, I think, any serious doubt.

First, then, the average behavior of a very large collection of irregularly moving objects has characters which are decidedly lawful, even although the laws in question are what may be called laws of chance.

The recent familiar use of statistical diagrams for illustrative purposes has made this law of chance more familiar to many classes of students than it was in the day when Maxwell wrote certain words, which you will find in his "Theory of Heat."[1] These words give you the very heart of the statistical aspect of nature.

> The distribution of the molecules according to their velocities is found to be of exactly the same mathematical form as the distribution of observations according to the magnitude of their errors, as described in the theory of errors of observation. . . . Whenever in physical phenomena some cause exists over which we have no control, and which produces a scattering of the particles of matter, a deviation of observations from the truth, or a diffusion of velocity or of heat, mathematical expressions of this exponential form are sure to make their appearance.

This, then, is in concrete form the law of random distribution, the form of iron necessity which one finds in the realm of chance.

All this law of chance variation was, of course, at that time no novelty, although the popular use of statistics has since made it more familiar. What was new, however, was the fact that when Maxwell computed the consequences which followed from supposing the existence of his swarm of colliding molecules with their chance distribution of velocities, he was able to deduce not only the principal physical properties of gases, but in particular those properties which, like all the phenomena which illustrate the second law of the theory of energy, are not expressible in terms of merely mechanical laws, unless these laws are applied to the case of a system complex enough to ensure that the velocities of its molecules shall approximate closely to this chance distribution.

Since Maxwell's time, the same theoretical methods have been applied to a vast range of physical phenomena, with the general result that the second law of the theory of energy is now generally regarded, by all except the extreme *Energetiker*, as essentially a statistical law. So viewed, the second law of energy becomes a principle stated wholly in terms of the theory of probability. It is the law that the physical world tends, in each of its parts, to pass from certain less probable to certain more probable configurations of its moving particles. As thus stated the second principle not only becomes a law of evolution, an historical principle, but also ceases to

[1] Page 309 of the Appleton edition of 1875.

be viewed as any mechanically demonstrable or fundamentally necessary law of nature. Whether nature is a mechanism or not, energy, according to the kinetic theory, runs down hill as it does for statistical and not for mechanical reasons. Energy need not always run down hill; and in fact would not do so if there were present in nature any persistent tendency, however imperfect, towards a suitable sorting of molecules. Maxwell suggested in his image of the demons sorting the atoms of a gas, how such a tendency might make energy run up hill instead of down, without the violation of any mechanical principle.

More recently Boltzmann, in his further development of Maxwell's hypothesis, pointed out how the theory of probability itself requires that, in the course of very vast intervals of time, there must occur some occasional concentrations of energy and some sensible unmixings—some reversals of the diffusion of gases, in case indeed the kinetic theories are themselves true. And still more recently Arrhenius has suggested that the nebulæ may furnish the conditions for the occasional if not the general reversal of the second law of the theory of energy. Of such speculations I can of course form no judgment. They interest us here only as examples of the logic of the statistical view of nature.

In sum, all these investigations have tended to this general result: If a law of the physical world does not appear consistent with the mechanical view of nature so long as you confine your attention to a single system of bodies, whose individual movements you follow and compute, this law may still become perfectly intelligible when viewed as the expression of the average behavior of a kinetic system complex enough to give an opportunity for the application of statistical laws, and for the use of the conception of probability.

VIII. THE CANONICAL FORM OF SCIENTIFIC THEORIES

All the foregoing instances may appear to you merely to suggest that, in dealing with mechanisms too complicated to be the object of a direct computation, our ignorance may force us to make use of statistical modes of computation. These statistical methods, you may say, are convenient devices whereby we neutralize, for certain special purposes, the defects of our mechanical knowledge.

If the insurance actuaries—so you may say—could use a sufficient knowledge of the world's mechanism, they would compute the precise time when each individual man is to die, just as the astronomers compute the eclipses. An almanac of mortality would take the place of the present nautical almanac. Everybody's funeral would be announced, if that were convenient, years in advance; and life insurance would appear to be a blundering and awkward substitute for scientific prediction. Because and only because, as a fact, no knowledge of the differential equations of the precise movements of matter, and no exact measurements of the accelerations or of the other rates of change in these movements gives us the power to predict the phenomena of nature in their detail, including the movements which determine life and death, we are obliged to substitute a statistical definition of the probable tendencies of a definable proportion of great numbers of men to die, in a way which varies with their numbers and their ages, for the precise knowledge of the hour of each man's death which we should all regard as a scientific ideal, if we could know the mechanism of life and death. The statistical view is a mere substitute for a mechanical view which our ignorance makes us unable to use, in the individual case, with sufficient accuracy. Such may be your comment.

The nautical almanac (so you may say) is the model of what applied science ought to to be. The mortality table is the convenient summary due to a necessary scientific evil. It is a device for recording our ignorance of the details of the world's mechanism along with our imperfect knowledge of certain probable and approximate tendencies to which the averages of many human lives are subject.

In other words, you may be disposed to insist: "Mechanical theories are the canonical forms towards which a growing scientific knowledge guides our way. Computations of individual events in terms of invariant laws whose validity is independent of time, are the models of what our scientific ideals seek. The statistical view of very complex mechanisms is an asylum in which our ignorance, perforce, has to find its refuge whenever, as in case of the swarms of molecules and the labyrinthine complications of organisms, the mechanical view of nature, as applied by us, loses its way."

In answer to this very natural comment, I am next led to say that, whether the natural world is a mechanism or not, the statistical view of nature would be, and so far as we know the facts is, applicable to sufficiently complicated systems of things and events, not as a mere substitute for these more exact computations which our ignorance of mechanical laws makes necessary, but as an expression of a very positive, although only probable and approximate, knowledge whose type all of the organic and social sciences, as well as most aspects of the inorganic sciences, illustrate. There is therefore good reason to say that not the mechanical but the statistical form is the canonical form of scientific theory, and that if we knew the natural world millions of times more widely and minutely than we do, the mortality tables and the computations based upon a knowledge of averages would express our scientific knowledge about individual events much better than the nautical almanac would do. For our mechanical theories are in their essence too exact for precise verification. They are verifiable only approximately. Hence, since they demand precise verification, we never know them to be literally true.

But statistical theories, just because they are deliberate approximations, are often as verifiable as their own logical structure permits. They often can be known to be literally, although only approximately, true.

This assertion is, in its very nature, a logical assertion. It is not any result of any special science, or of any one group of sciences. It solves no one problem about vitalism. It is a general comment on the value of the statistical point of view.

But, if the assertion is true, it tends to relieve us from a certain unnecessary reverence for the mechanical form of scientific theory—a reverence whose motives are neither rationally nor empirically well founded. It is the merit of Charles Peirce to have emphasized these logical considerations. Their importance for the study of scientific methods has grown greater with every year since 1891, when he began the publication of his remarkable papers in the *Monist*, entitled: "The Architecture of Theories," "The Doctrine of Necessity Examined" and "The Law of Mind." These papers are fragmentary; and yet in their way they are classical statements of the limitations of the mechanical view of nature, and of the significance of the statistical view of nature.

As I close, let me merely outline some aspects of Peirce's extension of the statistical view of nature beyond the range which Maxwell's and Boltzmann's study of the theory of gases directly exemplified.

IX. APPLICATIONS OF THE STATISTICAL VIEW TO THEORIES OF NON-MECHANICAL SYSTEMS. AGGREGATION AND ASSIMILATION AS STATISTICAL TENDENCIES

It at first seems, I have said, as if the statistical methods of the kinetic theory were applicable only to mechanisms whose complications were too vast to make it possible to follow in individual detail their necessary sequences of movements.

But this seeming is unfounded. Let me summarize in my own words a few considerations which Peirce summarily states, and which, to my mind, get a constantly increasing importance as the statistical view of nature comes to be applied to wider and wider fields of research.

Suppose an aggregate of natural objects which contains a very great number of members, each one of which is subject to some more or less exhaustively definable range of possible variations. These objects may be things or events, at your pleasure. They may be molecules or stars or cells or multicellular organisms or members of a society or observations of a physical quantity or proposals of marriage or homicides or literary compositions or moral agents or whatever else you will. The essential basis which is needed for a statistical view of such an aggregate is this:

First, the members of each aggregate must actually form a collection which is, for some physical or moral reason, a genuine and therefore in some way a definable whole.

Next, some more or less systematic tendency towards a mutual assimilation of the fortunes, the characters or the mutual relations of the members of this aggregate must exist. This tendency toward mutual assimilation may be of very various sorts.

The policyholders of an insurance company tend to assimilate the fortunes of their various investments when they all of them pay their premiums to the same company. The stars tend to a certain assimilation of the mutual relations amongst those photographs of their various spectra which chance to get collected on the photographic plates of the same astronomical observatory. For, as a consequence of this aggregation of photographs, the stellar spectra in question may tend to be classified; and the logical, as well as the other socially important, and the physical fortunes of objects which are once viewed or arranged or tabulated as objects belonging to the same class, tend, in general, to a further mutual assimilation.

Birds of a feather not only flock together, but tend to get statistically similar fortunes, when they come into chance contact with other birds or with breeders, with hunters or with biometrical statisticians.

All objectively well-founded classification is not only founded upon real similarities amongst the objects which belong to an aggregate, but tend to some increase of these similarities, in so far as these objects are not changeless mathematical entities, but are natural objects, whose fortunes are subject to change.

One of the most widely applicable laws of nature is, in fact, the law, wholly indefinable in mechanical terms, but always expressible in terms of statistical tendencies —the law that aggregation tends to result in some further and increasing mutual assimilation of the members of the aggregate. This assimilation may express itself in the fact that one classification or aggregation leads both logically and physically to another and deeper and also wider aggregation.

If the stars are already physically classified into two distinct drifts, which move through each other in two different directions, and if the stars in question tend to

get the photographs of their spectra assembled in the same observatory, then the classes into which the photographs tend in the long run to be grouped also tend to be such that, at least for some one resulting classification or aggregation of the photographs, the photographs of the spectra of the stars of one of the star drifts are grouped together, not only in the ideas which the astronomers form, but in the physical arrangements towards which certain groups of photographs, of symbols and of statistical tables, persistently tend.

The principles here involved depend upon the sorts of assimilation which the radiant phenomena of light make possible. For a photograph is a physical expression of a certain tendency whereby the structure of a photographic plate tends to be assimilated to the molecular structure and state of a radiating object—say a star. When the photographs of stellar spectra are grouped in classes, a secondary assimilation tends to take place, since similar spectra tend to get either placed or tabulated in similar ways. When this secondary assimilation of the photographs leads to an indirect discovery of the existence of the two star drifts themselves, a tertiary assimilation of the fortunes of those stars whose proper motions are sufficiently similar takes place, and tends to get represented in the knowledge of different astronomers.

The ideas of these various astronomers tend to further assimilation through the means used in scientific communication. The radiation of scientific knowledge continues the natural process which the radiation of light and the making of photographs of stellar spectra have already illustrated, and the rule continues to be illustrated that mutual assimilation is one aspect of classification and aggregation, and is a cumulative statistical tendency which accompanies them both.

The insurance companies and the transformation of modern civilization through the extension and aggregation of modes and devices whereby insurance is accomplished, furnish numerous other examples of this law of the fecundity of aggregation. The law, as I have said, holds in general for non-mechanical systems, although, as stellar evolution seems to indicate, it can also hold for mechanical systems. It may hold, in fact, for all natural processes which involve evolution.

Clerk Maxwell himself believed that the sharp distinctions which separate the different classes of elementary atoms, and the different types of molecular structure which determine the spectra of the molecules of different elements, are signs that no kinetic theory of the evolution of the chemical elements would ever be possible. It is precisely here that the latest advances, on the still so imperfectly defined outlying boundaries of physical and of chemical research, give a new significance to the statistical view of nature, by showing that if we take account of sufficiently large aggregates of things and of events, a kinetic theory of the evolution of chemical elements becomes a possibility worthy of future investigation, and certain to receive, in connection with the phenomena of radioactivity, further investigation upon statistical lines, whatever be the further fortunes of the mechanical view of nature, or of this problem about the evolution of the elements.

Of such speculations one can say that, if ever a theory of the evolution of the chemical elements becomes feasible, it will be, in part at least, a statistical theory, and will illustrate in new ways how widespread in material nature is the tendency to that mutual assimilation which all the phenomena of radiant energy illustrate, and of which the relatively uniform constitution and distribution of each one of the various chem-

ical elements through vast ranges of the physical universe may well be the result.

In brief, the evolution of stars, of elements, of social orders, of minds and of moral processes, apparently illustrates the statistical fecundity of nature's principal tendency—the tendency to that mutual assimilation which both defines aggregates, that is, real classes of natural objects, and tends to keep these classes or aggregates permanent in the world and to increase both their wealth of constitution and their extent.

Now it is this principle of the fecundity of aggregation which seems to be the natural expression, in statistical terms, for the tendency of nature towards what seems to be a sort of unconscious teleology—towards a purposiveness whose precise outcome no finite being seems precisely to intend. It is a statistically definable rule that changeable aggregates, when they are real at all, result from likenesses which their very existence tends both to increase and to diversify. The social fecundity of the principle of insurance illustrates this natural tendency. That marvelous result of the aggregation of scientific observers, of tabulations and of photographs, of the radiant phenomena which make the stars visible and of the microscopic phenomena and the logical interests which make probability definable—that marvelous result of these various aggregations which constitutes the whole procedure and outcome of modern inductive science itself, is an expression of this same general tendency—apparently the most vital and the most vitalizing tendency both of the physical and of the spiritual world—the tendency of aggregation and of classification to be fruitful both of new aggregations and of the orderly array of natural classes and of natural laws.

In the purely logical and mathematical worlds this tendency can get, and does get, precise description in terms of the pure logic of number and of order. In the physical world, in the world of time and of change, this principle gets further expressed as a statistical rather than a mechanical law—the law that classes, aggregations and organizations tend towards a definable sort of evolution.

As Charles Peirce pointed out, you need not suppose the real world to be mechanical in order to define and to conceive this sort of evolution. You need only suppose (1) the presence of the just-mentioned tendency to form aggregates, and to the mutual assimilation of the various parts of nature; (2) the statistically definable tendency to some sort of sorting or selection of the probable results to which any definable average constitution of the natural world at any moment leads; and (3) a tendency—and once more, a statistical and non-mechanical tendency, towards a formation of habits, and towards a repetition of such types of movement as have once appeared. Suppose these three tendencies (aggregation, selection and habit—and the statistical method shows these three to be widespread in the physical world); suppose these three, and you can define a process of evolution, never mechanical and never merely expressive of any previously settled designs, either of gods or of men. This process of evolution will then lead from mere chance towards the similation of mechanism, from disorderly to a more orderly arrangement, not only of things and of individual events, but of the statistically definable laws of nature; that is, of the habits which nature gathers as she matures. The philosophy of nature which will result will show how nature may well tend to appear in certain aspects more and more teleological, and to manifest what Greek vitalism found in nature. Whether the whole world is ultimately and consciously teleological or not, this view of nature would of course be unable to decide. But it would lay stress upon

the thought that what is indeed most vital about the world is that which also characterizes the highest life of the spirit, namely, the fecundity of whatever unites either electrons or souls or stars into streams or into other aggregations that, amid all chances, illustrate some tendency to orderly cooperation.

If this view of nature has any foundation, gentlemen, then, as the whole progress of inductive science illustrates, the way to further such scientific evolution is to get together, and to leave the rest to the statistically definable tendencies of nature. These are tendencies away from the chance distributions which the bell-shaped curve of random distribution illustrates, towards the orderliness of which the mechanical view of nature gives us one illustration, and by no means the most probably true illustration.

I should suppose, then, that whatever notes you may compare in these meetings, you will probably frequently and variously illustrate the statistical view of nature. This view is ill understood by those who think only how dry statistical tables and averages may seem. Mechanism is rigid, but probably never exactly realized in nature. But life, although it has its history, has also its statistics. And averages cease to be dry when they are averages that express the unities and the mutual assimilations in which the common ideals and interests, the common hopes and destinies of the men, of the social orders, of the deeds—yes, and perhaps of the stars and of all the spiritual world are bound up and are expressed.

Do you wish to experiment upon some new processes of social aggregation, of mutual assimilation, and of the study of photographs of your various spiritual spectra?

This practical question is for you to consider.

Josiah Royce
Harvard University

THE NATIONAL ACADEMY OF SCIENCES

The annual meeting of the Academy will be held in Washington on April 21, 22 and 23, 1914. Following is the tentative program:

MONDAY EVENING, APRIL 20

7:30 P.M.—Meeting of the council in the private dining-room of the Cosmos Club.

TUESDAY, APRIL 21

10:00 A.M.—Business meeting of the Academy in the Oak Room of the Hotel Raleigh.

1:30 P.M.—Luncheon in the private dining-room of the Hotel Raleigh. (In the event of unfinished business, an adjourned business session may be held in the Oak Room following the luncheon.)

4:00 P.M.—Auditorium, National Museum. Inauguration of the William Ellery Hale Lectures by Sir Ernest Rutherford, of the University of Manchester. (Open to the public.) Subject: "The Constitution of Matter and the Evolution of the Elements." (Illustrated.)

9:30 P.M.—Reception to the members of the Academy and their guests, at the home of Alexander Graham Bell.

WEDNESDAY, APRIL 22

10:00 A.M.—Auditorium, National Museum. Public scientific session for the reading of papers.

1:00 P.M.—Luncheon in the Oak Room of the Hotel Raleigh.

2:30 P.M.—Auditorium, National Museum. Public scientific session for the reading of papers.

8:00 P.M.—Annual dinner of the members of the Academy and their guests in the Oak Room of the Hotel Raleigh.

At the annual dinner of the Academy will occur the first presentation of the medal for "Eminence in the Application of Science to the Public Welfare" to George Washington Goethals and William Crawford Gorgas for distinguished service in building the Panama Canal. (Presentation private.)

THURSDAY, APRIL 23

10:00 A.M.—Oak Room, Hotel Raleigh. Business meeting of the Academy for the election

of members, foreign associates and two members of the council.

1:30 P.M.—Luncheon in the private dining-room of the Hotel Raleigh.

4:00 P.M.—Auditorium, National Museum. Second of the William Ellery Hale Lectures, by Sir Ernest Rutherford, of Manchester. (Open to the public.) Subject: "The Constitution of Matter and the Evolution of the Elements." (Illustrated.)

The chairmen of the various trust funds are requested to present at the meeting detailed written reports in accordance with instructions in rule 22, adopted at the annual meeting in 1911, which reads as follows:

The annual reports of the Committees on Research Funds shall, so far as the Academy has authority to determine their form, give a current number to each award, stating the name, position and address of the recipient, the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

At the scientific sessions of the academy, held in the Auditorium of the National Museum on April 22, papers will be presented as follows:

Pre-Cambrian Algonkian Algæ: CHARLES D. WALCOTT. (Lantern slides.)

Hewettite, Metahewettite and Pascoite, Hydrous Calcium Vanadates: W. F. HILLEBRAND, N. E. MERWIN AND FRED E. WRIGHT.

Two apparently different calcium vanadates are described, which resemble each other very closely and have the same composition—$CaO.3V_2O_5.9H_2O$—when holding their maximum water content at room temperature. One of them—hewettite—occurs at Minasragra, Peru, and has been noticed on a single specimen from Paradox Valley, Colorado. The other—metahewettite—occurs at numerous localities in western Colorado and eastern Utah. Both minerals are sparingly soluble in water. A third calcium vanadate—pascoite ($2CaO.3V_2O_5.11?H_2O$)— is also described. This occurs with hewettite at Minasragra. It is very soluble in water. The first and second minerals are regarded as hydrated acid hexavanadates—$CaH_2V_6O_{17}.8H_2O$—the third as a normal hexavanadate, $Ca_3V_6O_{17}.11?H_2O$.

The reasons for specific separation of hewettite and metahewettite are set forth in detail. All three minerals are so sensitive to changes in atmospheric humidity that their water content varies within wide limits at different times of the year. The removal of all or nearly all the water does not result in breaking down of the crystal structure, and until this has occurred the water is wholly or in great part taken up again when opportunity is offered.

The importance is emphasized of bringing all minerals that behave in this way to a definite maximum water content before analyzing them and of following carefully the course of dehydration under prescribed conditions. Detailed directions are given for such tests and for avoiding several sources of error. Attention is also called to two fairly constant associates of metahewettite. One of these (also a constituent of carnotite ores) is a gray hydrous silicate of aluminum, trivalent vanadium and potassium. The other is elemental selenium, the existence of which as a mineral species seems now for the first time established.

The Origin of Monocotyledony: JOHN M. COULTER.

The evidence of vascular anatomy, supported by the historical record, as well as by general morphological considerations, has demonstrated that the Monocotyledons have been derived from the Dicotyledons. It remained to obtain evidence of the transition from dicotyledony to monocotyledony. The two opposing views, each supported by considerable indirect evidence, are (1) that the monocotyledonous condition has arisen by a fusion of the two cotyledons, and (2) that it has arisen by a suppression of one of them.

Material of *Agapanthus umbellatus* (Liliaceæ) obtained from South Africa proved to be occasionally dicotyledonous, so that it was possible to determine the relation between the two conditions. The result has shown that neither one of the theories advanced to explain the origin of monocotyledony is tenable, but that this condition arises from the continuation of one growing point on the cotyledonary ring rather than a differentiation of two growing points. In every case, the cotyledonary apparatus begins as a ring, and continues its growth as one cotyledon or two. It is evident that there is neither suppression of one cotyledon nor fusion of two.

Heredity of Some Emotional Traits: CHARLES B. DAVENPORT.

Among emotional traits, violent temper and un-

controllable eroticism have an hereditary behavior that indicates that they are each due to a single positive determiner which may be regarded as interfering with the inhibitory mechanism. With a slightly less certainty marked cases of "Wanderlust" appear to be inherited as if sex-linked. Illustrated by diagrams and lantern slides.

The Causes of the Clotting of Blood: W. H. Howell.

In circulating blood or lymph a small amount of prothrombin is contained in solution in the plasma. This prothrombin is prevented from reacting with the calcium to form thrombin by the presence of an adequate amount of antithrombin, or, if any thrombin is formed, its coagulating effect on fibrinogen is prevented by the antithrombin. The normal fluidity of the circulating blood is dependent, therefore, upon the presence and action of the antithrombin. In blood-platelets and in leucocytes there is contained a supply of thromboplastic material (phosphatid-compound) and also of prothrombin. On the shedding of blood the disintegration of the platelets and, to a lesser extent, of the leucocytes liberates thromboplastin and prothrombin. The former neutralizes the antithrombin, the latter, together with the prothrombin already present in the plasma, is changed to thrombin by the action of the calcium. Cell-free plasmas may be clotted by the addition of thromboplastin (kephalin) to neutralize the antithrombin.

The Luminescence of Kunzite: Edward L. Nichols and Horace Leonard Howes.

The Prompt Distribution of Convulsants in Cardiectomized Frogs deprived of their Lymph Hearts: S. J. Meltzer.

Several years ago the writer reported that in frogs from which the heart was removed, an injection of strychnin, morphin or acid fuchsin brought on convulsions. For the two latter substances the effect was more prompt and rapid than in animals with normal circulation. The conclusions seemed to be inevitable that the distribution of these substances must take place by some mechanism other than the circulatory apparatus. Two years ago J. J. Abel stated that the success of the experiment depends upon the normal activity of the two anterior lymph hearts; when these are destroyed no convulsions can take place. In recent experiments carried out by Githens, of the Rockefeller Institute, Dr. Joseph, of the University of St. Louis, and by myself in a long series of experiments the lymph hearts were destroyed and after a day or two, when the animals recovered, the heart was removed and the substances injected. The result was as prompt as if the lymph hearts were intact. Furthermore the injections were made this time into the lymph sacs of the thigh and the substances therefore had to travel long distances. Apparently a quite efficient distribution may take place through the connected lymph spaces without the aid of any part of the circulatory apparatus.

Contributions to the Geology of Bermuda: L. V. Pirsson and T. Wayland Vaughan.

Recently a deep well, about 1,400 feet deep, has been bored in Bermuda Island. The samples taken from this well at regular intervals show that there is first penetrated a considerable depth of lime deposits produced by organic life, then follows, down to about 600 feet, brownish weathered igneous rock, after which black unoxidized lavas and igneous material persist to the bottom. The lime deposits contain the remains of organisms. The facts disclosed have important bearings on the origin and geological history of the island and on the problem of coral reef formations. The igneous geology is discussed by L. V. Pirsson and the later history and coral reef problem by Dr. Vaughan.

The lectures founded in memory of the late William Ellery Hale, of Chicago, will be inaugurated by Sir Ernest Rutherford, of the University of Manchester, who will speak in the Auditorium of the National Museum, Washington, D. C., on April 21 and 23, 1914, at 4 P.M.

The committee in charge has planned a series of such lectures covering several years on the general subject of evolution, which is designed to give a clear and comprehensive outline of the broad features of inorganic and organic evolution in the light of recent research. Sir Ernest Rutherford's lectures will deal with the Constitution of Matter and the Evolution of the Elements. Aided by many illustrations, including some of the experiments which brought to him the award of the Nobel Prize, Sir Ernest will explain how the discovery of radio-activity and the study of the electron have revolutionized our views on the nature of matter. By these new means of investigation, the chemical elements and the complex compounds which they unite to form may be shown to consist of units of positive and negative electricity. Moreover, all nega-

tive electrons are precisely alike, from whatever form of matter they may be derived. Thus we are prepared to witness some of the transformations of the chemical elements, such as the spontaneous disintegration of radium and the production of helium from it.

These addresses on the fundamental structure of matter will prepare the way for succeeding lectures, which will deal with the various transformations of matter involved in the evolution of the earth and its inhabitants.

The second course in the Evolution Series will be given at the next autumn meeting of the Academy by Dr. William Wallace Campbell, director of the Lick Observatory, Mount Hamilton, California. Provided with his raw material, as it were, by Sir Ernest Rutherford, Dr. Campbell will sketch the various types of bodies which make up the universe, describe their connection in systems, and explain the principal theories of stellar evolution. His object will be to show how stars and stellar systems are gradually evolved from an earlier state and to afford a view of the earth in its first phases of development. In this way the intimate relationship of the earth with the moon and the other bodies of the solar system will be made apparent, as well as the continuity of the process which connects the present with the remote past. Dr. Campbell will introduce some of the results of his extensive researches with the powerful instruments of the Lick Observatory and will employ a large collection of astronomical photographs for illustration purposes.

A distinguished European geologist will be invited to give the third course of lectures at the annual meeting of the Academy in 1915. Taking the earth from the hands of the astronomer, he will show how its surface features have been altered in the process of time. Later lectures, preserving the continuity of the series, will then enter the field of organic evolution and illustrate the bearing of recent investigations in paleontology, zoology and botany on the evolution of plant and animal life. The evolution of man will form the subject of a subsequent course, and the series will close with an account of the rise of the earliest civilizations, coming into touch with modern times in the life of the Nile Valley.

In all cases the lectures will be given by leading European and American investigators, whose personal researches have contributed largely toward the development of the fields of science which they represent. Every effort will be made to secure continuity and homogeneity of treatment, in order that the published lectures may unite into an adequate and well-balanced description of evolution in the broadest sense. The lecturers chosen will be able to eliminate unessential technicalities and to present their subjects clearly and intelligibly to general audiences. The series on Evolution should therefore appeal to a large public, interested in the broader aspects of science, but not necessarily familiar with its special methods or technical details.

The lectures will be open to the public without charge, and a cordial invitation is extended to all who may wish to attend them.

Arthur L. Day,
Home Secretary

Smithsonian Institution,
Washington, D. C.

THE AMERICAN PHYSICAL SOCIETY

A regular meeting of the Physical Society will be held at the Bureau of Standards, Washington, on April 24 and 25. Morning sessions will begin at 9:30.

Attention is directed to the following special features of the coming meeting:

1. The members of the Physical Society are invited by the National Academy of Sciences to attend the William Ellery Hale lectures by Sir Ernest Rutherford, F.R.S., upon "The Constitution of Matter and the Evolution of the Elements" (illustrated). The lectures are two in number, and are delivered in the auditorium of the National Museum on April 21, and April 23, at 4:00 P. M.

2. A special attraction will be the exhibit of apparatus arranged by a local committee of the Physical Society. Thus far entries have been received from more than thirty manufacturers, importers and industrial research estab-

lishments. University laboratories and federal scientific bureaus will be well represented, so that an eminently successful exhibit is assured.

3. A lecture by Sir Ernest Rutherford will be given Friday afternoon at 3:30, "On X-ray and Gamma-ray Spectra" (at the Bureau of Standards?).

4. The three sessions of the meeting for the reading of papers will be joint sessions with the Electrophysics section of the American Institute of Electrical Engineers. (The morning sessions will be in charge of the Physical Society and the Friday evening session in charge of the A. I. E. E.)

5. Another feature will be the opening of the newly-completed electrical building of the Bureau of Standards. The apparatus exhibit will be there installed.

6. Members of the Physical Society and others in attendance will be guests of the scientific staff of the Bureau of Standards at luncheon in the west laboratory, at 1:00 P. M., on the days of the meeting.

7. Saturday afternoon there will be an opportunity to visit points of interest in the city, under the guidance of local members of the A. I. E. E. It is possible also that another session will be provided for the reading of papers, in view of the unusual number of titles presented.

A. D. Cole,
Secretary

THE AMERICAN JOURNAL OF BOTANY

At the Atlanta meeting of the Botanical Society of America, in January, 1914, plans were perfected for the publication of a new journal, known as the *American Journal of Botany*. As stated in the introductory note to No. 1, the need of increased facilities for the prompt publication of the results of botanical investigation has been keenly felt for some time, and the promptness with which this new opportunity has been taken advantage of, as indicated by the receipt of copy for the new venture, shows that the establishment of a new publication is amply justified.

An agreement has been entered into between the Botanical Society of America and the Brooklyn Botanic Garden for cooperation in the publication of this *Journal*. By the terms of this agreement, which has been entered into for a period of three years, financial responsibility is assumed jointly by the Botanical Society of America and the Brooklyn Botanic Garden. The Garden names the business manager and one member of the editorial board, and the Botanical Society of America elects the editor-in-chief and four other members of the editorial board.

The *Journal* is the official publication of the Botanical Society of America, and business offices are maintained at the Brooklyn Botanic Garden and at 41 North Queen Street, Lancaster, Pa.

It is the plan for the present to include contributions to all branches of botanical science, and longer papers will be especially welcome. It is not the present plan to include reviews of literature. Each issue will consist of about fifty pages, and contributions will be welcome from all botanists. There will be ten numbers to a volume.

All correspondence with reference to prospectus, subscriptions, advertisements, and exchanges with other publications, should be addressed to American Journal of Botany, Brooklyn Botanic Garden, Brooklyn, N. Y., and correspondence concerning editorial matters and all manuscript submitted for publication should be addressed to the editor-in-chief, Professor F. C. Newcombe, Geddes Heights, Ann Arbor, Michigan. The other members of the editorial board for 1914 are C. Stuart Gager, business manager, Brooklyn Botanic Garden; Robert A. Harper, Columbia University; Duncan S. Johnson, Johns Hopkins University; L. R. Jones, University of Wisconsin; George T. Moore, Missouri Botanical Garden; and Edgar W. Oliver, Brooklyn Botanic Garden.

THE CANADIAN ENTOMOLOGICAL SERVICE

Thirty years ago, in 1884, the Canadian government appointed a Dominion entomologist to advise agriculturists and others regarding the control of insect pests. Two years

later on the establishment of the experimental farms system, Dr. James Fletcher, who occupied the position, was attached to the new branch of the Department of Agriculture in the joint capacity of entomologist and botanist, which position he occupied with conspicuous success until his death in 1908. The growth in importance of the subjects necessitated their separation and accordingly divisions of entomology and botany were created. Dr. C. Gordon Hewitt was appointed Dominion entomologist in 1909 and entrusted with the work of organizing the new division of entomology of the experimental farms branch of the Department of Agriculture, with offices and laboratory at the Central Experimental Farm, Ottawa.

The urgent need of legislation in order to permit action to be taken to prevent the introduction into Canada and spread within the country of serious insect pests and plant disease was responsible for the passage of the Destructive Insect and Pest Act in 1910. The still greater need of investigations on the insect pests affecting agriculture, forestry and other branches of human activity has led to the establishment of field or regional laboratories in different parts of Canada with trained entomologists in charge to study local problems.

Owing to the consequent expansion of the entomological work along investigatory and administrative lines and the fact that such work did not constitute a necessary part of the work of the experimental farms system and executively was virtually distinct, the entomological service has now been separated from the experimental farms branch and has been constituted an independent branch of the Department of Agriculture under the direction of the Dominion entomologist. It is proposed to erect a building to provide offices and laboratories for the new entomological branch. Will correspondents kindly note that all official communications and publications should be addressed to "The Dominion Entomologist, Department of Agriculture, Ottawa."

This reorganization, which will also include the establishment of a national collection of the insects of Canada in the Canadian National Museum (The Victoria Memorial Museum) at Ottawa under the care of the Dominion entomologist, marks an important step in Canadian entomology. It will result in a still greater development of the study of Canadian insects along scientific and practical lines.

SCIENTIFIC NOTES AND NEWS

AT the meeting of the American Philosophical Society to be held at Philadelphia on April 23, 24 and 25, a large and important program of scientific papers will be presented. An account of the meeting with abstracts of the papers will be published in SCIENCE.

MR. F. W. HODGE, of the Bureau of American Ethnology, has been elected an honorary member of the Sociedad Científica Antonio Alzate of the City of Mexico.

PROFESSOR LAWRENCE MARTIN, of the University of Wisconsin, has been elected a corresponding member of the Kaiserlich-Königliche Geographische Gesellschaft in Vienna.

THE Austrian Zooological and Botanical Society has awarded the Archduke Rainer gold medals to two members of Yale University, Dr. Ross G. Harrison, Bronson professor of comparative anatomy, and Dr. George R. Wieland, lecturer in paleobotany.

THE British Local Government Board has authorized the following special researches, to be paid for out of the annual grant in aid of scientific investigations concerning the causes and processes of disease:

1. An investigation by Dr. Eardley Holland into the causes of stillbirths.

2. A continuation of the Board's inquiry into the cellular contents of milk by Professor Sims Woodhead.

3. A continuation of the Board's inquiry into the causes of premature arterial degeneration by Dr. F. W. Andrewes.

4. An investigation by Dr. M. H. Gordon and Dr. A. E. Gow into the etiology of epidemic diarrhœa in children.

THE council of the Royal Geographical Society has decided to award their royal medals and other honors for the present year as fol-

lows: Founder's medal, Professor Albrecht Penck, professor of geography at Berlin and director of the Oceanographical Institute; Patron's medal, Dr. Hamilton Rice, of Boston, Mass., known for his explorations of the region of South America drained by the headwaters of the Orinoco and of the northern branches of the Amazon; Murchison grant, Commander H. L. L. Pennell, R.N., a member of the Antarctic expedition of 1910, and selected by Captain Scott to command the *Terra Nova* after the landing of the shore parties; Gill memorial, Mr. A. E. R. Wollaston, who has made extensive journeys in many parts of the world, chiefly for zoological work; Cuthbert Peck grant, Dr. J. Ball, employed in the geological survey of Egypt for the past eighteen years; Back grant, Mr. J. N. Dracopouli, known for his work in the Sonora desert of Mexico and for his expedition to the Lorian Swamp.

The former students of Dr. J. McKeen Cattell, professor of psychology in Columbia University, at a dinner held in New York on April 8, presented him, in celebration of his completion of twenty-five years as professor of psychology, with a "Festschrift" in the form of reviews of his researches and of work in psychology to which they have led. The contents of the volume are:

"Work on Reaction Time," by V. A. C. Henmon.

"Studies of Reading and Perception," by Walter F. Dearborn.

"The Association Method," by F. Lyman Wells.

"Psychophysical Contributions," by R. S. Woodworth.

"Studies by the Method of Relative Position," by H. L. Hollingworth.

"The Study of Individual Differences," by E. L. Thorndike.

On April 6, 7 and 8, there was held at Columbia University a Conference on Individual Psychology by former students of the department of psychology, at which thirty papers were presented.

Dr. M. Miyoshi, professor of botany in the Imperial University of Tokyo, is visiting the scientific institutions of the United States.

Princeton University has granted leaves of absence for the academic year 1914–15 to Professor H. D. Thompson, of the department of mathematics; and to Philip E. Robinson, assistant professor of the department of physics.

The American Association of Pathologists and Bacteriologists met in Toronto, on April 10 and 11, under the presidency of Professor J. J. McKenzie, of Toronto University. There also met at Toronto the International Association of Medical Museums, with Professor R. M. Pearce, of Philadelphia, as president, and the American Association for Cancer Research, under the presidency of Dr. Ernest E. Tyzzer, of the Harvard Medical School.

Mr. F. J. North, assistant in the geological laboratory, King's College, London, has been appointed assistant keeper in the department of geology in the National Museum of Wales.

Professor M. Fréchet, of the University of Poitiers, will give at the University of Illinois during the academic year 1914–15 a course of lectures on general analysis.

Indiana University will hold, on April 16 and 17, a conference on educational measurements. The principal speaker is Professor E. L. Thorndike, of Teachers College, Columbia University.

Dr. John A. Brashear, of Pittsburgh, recently delivered two illustrated lectures at the University of Illinois on "The Contribution of Photography to our Knowledge of the Stellar Universe," and "Engineering Problems in the Construction of Large Telescopes." The lecture on celestial photography was held in the university auditorium with an audience of fifteen hundred persons.

Dr. L. A. Bauer gave on April 3, in the Engineering Societies Building, the evening lecture at the first joint meeting of the American Geographical Society and of the Association of American Geographers, his subject being "The General Magnetic Survey of the Earth," illustrated by lantern slides of the work of the *Carnegie*, and of the various expeditions to more or less unexplored countries.

THE annual John Lewis Russell lecture of the Massachusetts Horticultural Society was delivered on March 21, by Dr. Perley Spaulding, pathological inspector of the Horticultural Board of the U. S. Department of Agriculture. The subject was "Undesirable Foreign Plant Diseases."

DR. M. W. TWITCHELL, the assistant geologist of New Jersey, lectured before the department of geology of Princeton University on March 16, 20, 23, 27 and 30, the general subject of the series being "The Geology of New Jersey."

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, gave two lectures at Rutgers College on March 25 and 26, one before the New Jersey State Microscopical Society on "Primeval Man," the other before the Phi Beta Kappa Society on "The Dawn of Art."

PROFESSOR SAMUEL W. WILLISTON addressed the Chicago chapter of the Sigma Xi at its regular winter quarter meeting, on March 11, on the topic: "Recent Discoveries Relative to the Early Land Life of North America."

ON March 28, Professor C. H. Shattuck, of the Forestry Department of the University of Idaho, delivered a lecture before the Puget Sound Branch of the American Chemical Society on "Wood Processing."

DR. ALEXANDER F. CHAMBERLAIN, professor of anthropology at Clark University, died on April 8, at the age of forty-eight years.

DR. JOSEPH D. BRYANT, professor of surgery in the University and Bellevue Hospital Medical College, died in New York on April 8, aged sixty-nine years.

DR. ALFRED CONOR, vice director of the Pasteur Institute at Tunis, has died from infection contracted in his experimental work.

THE U. S. Civil Service Commission announces an examination for mining engineer in the Bureau of Mines, Department of the Interior, for service in the field, in relation to coal mining or metal mining, at salaries ranging from $2,400 to $4,000 a year. For the same bureau there will be held examinations for mine statistician and for assistant-engineer of mine tests at Pittsburgh at salaries ranging from $1,800 to $2,400.

MR. ANDREW CARNEGIE has given $100,000 to the New York Zoological Society to provide a pension fund for the New York Zoological Park and the Aquarium. The scientific staff and the employees will contribute annually 2 per cent. of their salaries, and any sum that may be lacking will be made up by the Zoological Society.

THE Rockefeller Institute for Medical Research, New York, announces that it has received from Mr. John D. Rockefeller an additional endowment of $1,000,000 for the purpose of organizing a department for the study of animal diseases. A gift of $50,000 has also been received from Mr. James J. Hill, for the study of hog cholera. The announcement says: "It is the expectation of the trustees of the institute that the new department by making possible a very thorough and exhaustive study of animal diseases by trained experts will prove a great boon to raisers of cattle, hogs, sheep, and other animals, as the opinion has been expressed that many of the diseases could be held in check and perhaps practically stamped out if the breeders had practical knowledge on which to act. With the present facilities at hand, the income from the $1,000,000 endowment will make it possible to carry on the work on a broad scope at once."

THE department of terrestrial magnetism of the Carnegie Institution of Washington, founded on April 1, 1904, is now occupying its new building, which has been especially erected, at 36th Street and Broad Branch Road, Washington, D. C., to provide the requisite facilities for the varied research work of the department, both along experimental and observational lines.

SIR ERNEST SHACKLETON has bought the ship *Polaris*, now at Sandefjord, to be his "flagship" on his forthcoming Antarctic expedition.

THE Swedish government has appropriated $13,500 for traveling expenses to be dis-

tributed among Swedish engineers who desire to visit the Panama-Pacific Exposition in San Francisco in 1915.

THE fiftieth meeting of the New England Association of Chemistry Teachers will be held in Boston on Saturday, April 25, 1914. The morning session will be devoted to the past, present and future of the association. Past presidents will speak, and the history of the association will be read. A complimentary luncheon will follow. It is hoped that the afternoon session will include a moving picture exhibition of chemical industries. In the evening there will be a reception and collation, followed by speaking, at the Copley Plaza.

THE twenty-fifth session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, Long Island, will be held from June to September. The regular class work will begin Wednesday, July first, and will continue for six weeks, to August 12. The instruction offered includes a course in field zoology by Dr. H. E. Walter, of Brown University, assisted by Dr. S. I. Kornhauser; in bird study by Mrs. H. E. Walter; in comparative anatomy by Professor H. S. Pratt, of Haverford, and Dr. D. D. Whitney, of Wesleyan University; in animal bionomics and evolution by Dr. C. B. Davenport; cryptogamic botany by Professor H. H. York, of Brown University, and Dr. W. E. Maneval; systematic and field botany by Professor John W. Harshberger, of the University of Pennsylvania. Opportunities are also offered for investigation in zoology and botany. A training course for field workers in eugenics is given under the direction of Dr. C. B. Davenport and Mr. H. H. Laughlin. The complete announcement may be got by addressing the Biological Laboratory, Cold Spring Harbor, N. Y.

THERE are now being assembled in the United States National Museum, the bones of a very small three-horned dinosaur which is being made the type of a new species. This diminutive dinosaur, when completely assembled, will measure about six feet in length and stand only about three feet high. Its head is twenty-two inches long. When its bones are compared with those of the larger members of this extraordinary family of reptiles, it will be seen that this specimen is less than one fourth of their size. In the National Museum are several skulls of one of the large horned dinosaurs, *Triceratops*, which measure from six to eight feet, and in one case, nine feet. The group to which this new member belongs is called the *Ceratopsia*, from the horns which adorn their heads; two above the eyes and one on the end of the nose. Unlike the others, this species has small and not prominent horns over the eyes, while the nasal horn is an outgrowth of the nasal bone and not an additional growth, as is the case with the others. Another peculiarity is that this horn is split lengthwise in such a manner that one side has the appearance of having slipped by the other. Its jaws are like those of a turtle, there being no front teeth but a sharp curved beak. Farther back in the jaws, however, are very finely sculptured cutting teeth, which show the animal to have been herbivorous. Like the other members of this group, it has a deep collar known as a frill, but in this species it has an open space on either side of the neck. The frill was covered with horn and formed a defensive armor for the protection of the neck. This particular specimen was found with the foot and tail articulated, which makes it especially interesting as being the first complete and connected specimen ever obtained. The foot has four toes, the first with two bones, the second with three, the fourth with five, while only a trace of the fifth toe remains, tending to show the loss of that member through disuse, as is the case with the horse. Parts of the other feet are also in this collection, as well as nearly all the bones of one individual. In the whole specimen there are but few bones and parts which will have to be restored. Considering that the first specimens of this family were discovered some forty years ago, it is curious that this small individual is the most complete one that has been found. These fossils were found by Mr. Charles W. Gilmore during the summer of 1913, while he was working for the Geological

Survey in the Blackfeet Reservation in northwestern Montana. The partial skeletons of five individuals were uncovered at the same time and form a most valuable addition to science. Mr. Gilmore has written a preliminary paper on the new species, published in the Smithsonian Miscellaneous Collections, and is working on the assembling of the specimen for exhibition in the National Museum.

California state inspectors at San Francisco have found a new canker disease on chestnut trees recently imported from Japan. According to Dr. Haven Metcalf, the government's expert on such diseases, this appears to be of the same type as the chestnut blight which is ravaging the forests of the eastern United States, and it is possible that the new disease would be equally destructive if it became established in this country.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board has promised to give $750,000 to Wellesley on condition that the balance of the $2,000,000 restoration and endowment fund is completed by January 1, 1915.

It is said that one million dollars will be received by the University of Pennsylvania from the estate of Dr. Louis A. Duhring, for many years professor of dermatology. At the time of his death on May 8, 1913, his bequest was estimated at only $400,000.

Grinnell College has completed its $500,000 endowment fund. Of this sum $100,000 was given by the General Education Board and the rest was raised by the college. The productive funds of the college now total more than $1,300,000. Of the amount just secured, $150,000 is to be devoted to the erection of new buildings.

The managers of the Presbyterian Hospital, New York, have taken action reorganizing the administration of the scientific and therapeutic work at the hospital so as to provide for single responsibility for both the medical and the surgical services. Dr. Theodore C. Janeway, Bard professor of the practise of medicine in the College of Physicians and Surgeons, Columbia University, has been designated medical director of the hospital, and Dr. George E. Brewer, professor of surgery, has been designated surgical director. Dr. William G. MacCallum, professor of pathology, has been appointed pathologist at the Hospital.

Professor Alan W. C. Menzies, Ph.D., now head of the department of chemistry at Oberlin College, has been elected professor of chemistry at Princeton University. Other changes are Dr. Edward Gleason Spaulding, promoted to a full professorship in philosophy; and Dr. Thomas Hakon Gronwall, elected assistant professor and preceptor in mathematics.

Recent promotions in the faculties of the University of Chicago include the following: To professorships: Harlan H. Barrows, geography; and Ernest J. Wilczynski, mathematics. To associate professorships: Elliot R. Downing, natural science (College of Education); Albert Johannsen, petrology; Walter S. Tower, geography. To assistant professorships: Storrs B. Barrett, Yerkes Observatory; Albert D. Brokaw, mineralogy and economic geology; Rollin T. Chamberlin, geology; and Arno B. Luckhardt, physiology. The new appointments include that of Oliver J. Lee to an instructorship in astronomy.

James Withycombe has resigned his position as director of the Oregon Agricultural College Experiment Station.

Dr. William E. Hocking, professor of philosophy in the University, has accepted a chair of philosophy in Harvard University.

Mr. G. H. Hardy, M.A., fellow of Trinity College, University of Cambridge, has been appointed to be Cayley lecturer in mathematics, and Mr. A. Berry, M.A., fellow of King's College, a university lecturer in mathematics.

DISCUSSION AND CORRESPONDENCE

MINERAL NOMENCLATURE

The need for revision of mineral nomenclature has been recently emphasized by Professor Austin F. Rogers, of Stanford University.[1] While I agree in the main with the

[1] *Proc. Amer. Phil. Soc.*, 52, 606–615, 1913.

views he expresses, it seems to me that his plan of treatment of isomorphous series is likely to complicate rather than simplify matters. Professor Rogers proposes that minerals be named by the predominant molecule of the isomorphous series, that isomorphous admixtures be indicated by adjectives, and that chemical prefixes be restricted to artificial substances. It would appear to me preferable to have mineral names apply to the isomorphous series as a whole, and, in most cases, to use chemical prefixes for end-members of series, whenever it is desired to discuss their relations.

The difference between these methods can best be brought out by citing a few examples. For instance, according to Rogers' plan the term carnotite would apply only to a (theoretical) potassium end-member of the isomorphous series of double uranyl vanadates, tyuyamunite to the calcium end-member. Specimens in which both are present would have to be called calciferous carnotite, if potassium predominated, and kaliferous tyuyamunite if calcium predominated, and indeed an analysis would be necessary before the material could be correctly named at all. According to my plan the name carnotite would apply to the isomorphous series itself, and could then continue to be used by laymen—miners, dealers, newspaper writers—to whom the exact composition is of no significance, to describe any sample of the mineral; while the compound names calcio- and kalio-carnotite would be used by the specialist discussing the composition of a given specimen, or its relations with other minerals.

The first plan would also do away with a number of well-known, useful, mineral names—with axinite, columbite and wolframite for instance, because they are made up of iron and manganese end-members—and, in general, with every name of a mineral as soon as it is discovered to be an isomorphous mixture. It would further require the introduction of two new names, for the end-members, in most cases. According to the second, on the other hand, advance of knowledge would not necessitate either the discarding of established names, nor the introduction of wholly distinct, independent, arbitrary ones, but only the addition of appropriate chemical prefixes, yielding ferro- and mangano-axinite, ferro- and mangano-columbite, etc. Some of these compound names have already been introduced, and have proved very useful in discussions of the relationships of the minerals; and they can cause no ambiguity so long as it is definitely understood that they apply to end-members of series only. Natronorthoclase in the sense of orthoclase containing sodium replacing part of the potassium, cobaltocalcite in that of calcite containing a little cobalt, etc., would, however, have to be dropped (as also recommended by Rogers).

In the few cases where the end-members of a series are common, well-known and well-characterized minerals, convenience may demand that independent names be retained as synonyms of these compound ones. Thus while wolframite remains the name for the isomorphous mixtures of iron and manganese tungstates, ferberite and hübnerite may at times be used instead of ferro- and mangano-wolframite, since they are sufficiently characteristic to be recognized by miners, dealers and beginning students. Yet I have found that practically every mineralogist, when asked what ferberite is, will reply "wolframite high in iron" rather than "iron tungstate." So, even if the distinct names are retained in this case the compound chemical ones had better be used synonymously with them.

My suggestions are then, in short, that when a mineral is discovered to be an isomorphous mixture of two (or more) components the species name shall be regarded as a group name, representing any and all members of the series; that the end-members in general shall be designated by chemical prefixes applied to the species name; but that if the end-members are so distinct, characteristic and well known that they can be thought of independently, and already have separate names, that these names be retained as synonyms of the compound, chemical, ones. If this plan should be systematically applied it would simplify mineral nomenclature with a minimum of

change from existing conditions, apparently a highly desirable result. Edgar T. Wherry

National Museum,
Washington, D. C.

THE WELLESLEY FIRE

To the Editor of Science: The article of Professor Caroline B. Thompson entitled "The Wellesley Fire" stated that "the more important losses to physics are lantern slides, a collection of crystals, a unique collection of Nicol prisms. . . ." The lantern slides, although a useful adjunct to the apparatus, represented an inconsiderable part of the total loss. It is true that it will be difficult to duplicate the larger crystal sections and that the Nichol prisms, although by no means forming a "unique collection," were unusually good for a college of liberal arts as indeed was the entire equipment.

In a loss amounting in the aggregate to many thousands of dollars it is idle to enumerate particular items, but it may be noted that the department was especially fortunate in its equipment for the study of advanced optics and electricity. The apparatus included a commercial photometer, a large optical bench for the study of interference and diffraction effects, a Michelson interferometer, Lummer plate spectroscope, polariscopes, polarizing microscopes, Frick polarimeter, apparatus for the Zeeman effect, etc. Recently considerable time had been devoted to developing an experimental lecture course in "Electric Oscillations." To bring the equipment again to the same degree of efficiency will be the work of years. Louise Sherwood McDowell

Wellesley College

SCIENTIFIC BOOKS

Across Unknown South America. By Henry Savage-Landor. Two volumes. Boston, Little, Brown & Company. 1913. Pp. xxiii + 377 and xvi + 439, illustrated.

A map given at the end of the first volume shows that the author traveled extensively in various parts of South America, but it is not clear which part of that continent he regards as unknown. From Rio he went to S. Paulo, and thence to Araguary in western Minas by railway. From there to the city of Goyaz he traveled a much used road. From Goyaz he went westward on the road leading to Cuyabá. That road is not only much traveled and well known, but is shown on most maps of Brazil, such as Stieler's hand atlas and Baron Homem de Mello's atlases of Brazil, 1882 and 1909. There is even a telegraph line connecting the city of Goyaz with the city of Cuyabá. Francis de Castelnau made the trip in 1844, and his account of it is given in detail in the second volume of his "Expedition dans les parties centrales de l'Amérique du Sud," pages 218–282.

At Capim Branco, near Cuyabá, the author abandoned the main road and struck out across country by compass. The various disagreeable experiences off the main road were such as one would naturally expect, whether traveling in the interior of Brazil or in the interior of Pennsylvania. Little wonder that his men objected. This wandering about through the woods seems to have been regarded as exploration of an unknown region, though it is to be noted that he found farmers living there, and that the names of the streams were known to his companions.

After a few days in this "unknown" region he came out in the road leading from Rosario to Diamantino, and near the latter place took a canoe, without the necessary outfit, and descended the Arinos and Tapajos.

Here again he seems to regard the region as unknown. But the Arinos and Tapajos, in spite of their many and difficult falls and rapids, have been navigated constantly for more than a hundred and fifty years. Father Ayres de Cazal in his "Corografia Brazilica," published at Rio in 1817, says (Vol. I., p. 261) that in 1747 Captain João de Souza descended to Pará by way of Rios Arinos, Tapajos and Maranhão, and returned by way of the Madeira with canoes laden with European goods.

Dr. Mello Moraes in his "Corografia historica do Imperio do Brasil," Rio, 1859, 486, speaks of the voyage of João de Souza in 1747, but adds that Leonardo de Oliveira descended that river in August, 1742.

Joaquim Ferreira Moutinho, author of "Noticia sobre a provincia de Matto Grosso," S. Paulo, 1869, in speaking of the guaraná trade in Matto Grosso, says (p. 212) that the great consumption of this article keeps up the trips to Pará by way of the rivers Preto, Arinos, etc. This author speaks at length of the trips on the Arinos and Tapajos and gives the distances between the principal falls, and adds that the trip to Pará is made nowadays much more easily than formerly on account of the experience of the pilots and canoemen (p. 216).

Dr. Severiano da Fonseca in his "Viagem ao redor do Brasil," I., 75–79, tells of various trips up and down the Arinos and Tapajos, and gives the distances between various points.

In 1827 G. H. von Langsdorff, the well-known traveler, then Russian consul-general to Brazil, made a trip down the Arinos and Tapajos. There is a brief account of it in the "Revista do Instituto Historico do Brazil," Vol. XXXVIII., 348–349.

The writer of this review went to Diamantino in 1882 with the purpose of descending the Arinos and Tapajos to Santarem. There was a regular traffic on the river, and during his short stay at Diamantino a canoe loaded with guaraná arrived from the lower river. The voyage was not made, however, for the simple reason that the canoemen were in debt at Diamantino, and their creditors would not allow them to leave unless their debts, amounting to several thousand dollars, were paid.

If it is too much to expect that the writer of such a book should take the trouble to acquaint himself with the older literature of the subject, surely it is not unreasonable to expect him to look through the indexes of the Royal Geographical Society of London in order to find out whether the region he traversed was unknown. Volume thirty-two of the *Journal* of that society, pages 268–280, contains an account by Chandless of his trip down that river more than fifty years ago, together with his determinations of latitudes and longitudes.

Inasmuch as but little is known of the details of the geology of the region between Goyaz and Cuyabá, the reviewer was much interested at first in the lava flows, ashes, volcanoes and craters reported across Goyaz and Matto Grosso (pages 171–291). These phenomena were quite unexpected, and their mention on almost every page led to suspicion first, and later to a comparison with the notes of the trip across the same region made by Castelnau in 1844. Evidently the author mistook for volcanic phenomena the iron cemented rocks known in Brazil as *canga*. The book fairly swarms with such absurdities and half truths.

Pages 181 to 230 of volume I. are devoted to the Bororó Indians, their customs and legends. One is amazed at the great amount of material gathered by a person who knew nothing of the language. The length of his stay among them is not definitely given, but he left them before May 20 (p. 233), and as he had entered Matto Grosso May 11, it is clear that he was with the Bororós less than a week.

The trip down the Arinos and Tapajos was one long series of difficulties in passing falls and trouble with his men. On the lower Tapajos he left the river and struck out afoot through the forests, and, as one would expect, he was soon in trouble again with his men, and out of food in addition to the inconveniences naturally to be expected in such a region.

From a scientific point of view such a book is not worthy of review space. The cosmic and ethnologic theories propounded in the preface, and the evidence on almost every page of untrustworthiness of statement put it quite out of the rank of books that can be regarded as contributing to any branch of science. It is a great pity that so much energy and money should have been expended to such little purpose.

By his own confession he could not control his men, and the reader is constantly wondering how long such an expedition can hold together, and whether the author will starve to

death or get drowned or killed right away or a little later on.

That he underwent great inconveniences and sufferings goes without saying. Such a trip can not be made in a tropical country without them; but it is questionable whether readers should be bothered with his mosquitoes, his ants, his cattle ticks, and his runaway mules.

The photographs are the one redeeming feature of the book. J. C. BRANNER

A Text-book on the Teaching of Arithmetic. By A. W. STAMPER. New York, American Book Co. Pp. 1 + 284, including bibliography and index.

This book is a real contribution to pedagogy. for although its author disavows novelty in theory and completeness in scope, he has come nearer to writing a text-book in the teaching of arithmetic for beginners than has any other writer. It differs from the other excellent works on the same subject, such as those listed in the author's bibliography, in that it gives more space to instruction in the details of method and in class-room practise than to inspirational matter. It summarizes and applies the results of pedagogical research instead of dwelling upon their origin. In comparison with other books on the teaching of arithmetic, it is a manual of method rather than a reference book for the teacher's professional library.

As to its fitness for this purpose, it covers well the courses in the teaching of arithmetic given in our better normal schools. It is a well-rounded and well-balanced treatment of school. It is in general accurate as to fact, and sound in doctrine. The author has profited by his labors at Teachers College, Columbia University, particularly by his access to the great collection of original arithmetical works gathered there. These sources, supplemented by the accurate digests and classifications, and the collections of related mathematical apparatus, constitute the most significant assemblage of historical material on the subject of arithmetic to be found anywhere in the world.

But with all this the book is a chart of the beaten path. It will serve to help the laggards rather than to blaze a new trail. To some the book will seem to be written wrong end to. As it stands the order of discussion is: Origin (Chap. I.), Logic (Chap. II.), Subject Matter (Chaps. III.–VI.), Method (Chaps. VIII.–X.), Purpose (Chap. XI.). But among these topics why should not the last be first? The author makes aim or purpose the first consideration in his typical method lessons, and states (pp. 248–249) the controlling aim in the teaching of arithmetic. If the discussion of the selection, presentation and study of subject matter had been controlled from the start by the real *purpose*, it would not have greatly modified the conclusions of this volume. But it would have thrown a flood of light on why we are told to teach or not to teach certain things, and why we are told to teach in a prescribed way. The subject, if approached from this stand-point, would necessitate discussing, to a greater extent than the author does, the attitude of the pupil, who, after all, is the first consideration, the chief beneficiary and the sole legatee in the teaching of arithmetic.

The following more specific references may be of value: Pp. 9–18: A pragmatic treatment such as indicated above would relegate these meager nine pages of history to subordinate notes under related topics in later chapters. P. 18, questions 5 and 6, are of little value. P. 20: The *working* definitions explained at the bottom of the page should be emphasized as the kind of most value in arithmetic. P. 29: It would help the teacher, if the author had admitted that counting is measuring in the broadest sense. P. 30: the last paragraph could be strengthened thus: To the statement, "The multiplicand and the product being concrete," add "and of the same kind." Also to the statement, "The dividend is always concrete," should be added, "if either of the other terms are." P. 43: Young teachers may be led to overvalue work in artificial scales. P. 44: The expression, "When the first nine," would better be "when the column at the left." P. 51: The teaching of casting out nines is of doubtful value as a pratical check required in the universal course of study. P. 58: Re-

mainders should be taught before formal division. Thus, when the pupil knows that four sevens are twenty-eight, he should learn that thirty is four sevens and two units remaining. P. 63: The Euclidean method of greatest common divisor is referred to without explanation. P. 74, last paragraph of the example: The reason "Since we get the same answer . . ." is not sufficient and is inexcusable because the real reason is so apparent. In the process of reducing the fractions to their common denominators the numbers 8 and 9 are actually found thus, 4×2, 3×3. P. 99: This is too advanced to be of practical value in the grades. P. 101, last paragraph: Although the author has good precedent for this, it is surely a perversion to teach that "hundredths" and "per cent." are interchangeable. For if so, then 7.07 per cent. could read seven and seven per cent. per cent., an unfortunate confusion. Per cent. is primarily a rate per hundred, and its presentation as such would not exclude the desirable things in the author's subsequent treatment. P. 110 (*a*): "Times greater than" is a loose use of language for "times as great," probably due to the author's effort to carry out an analogy to percentage. Pp. 109–111: This correspondence between percentage and the processes with integers and fractions is not sufficiently significant to warrant its use in the class-room, and is of little value to the teacher. Pp. 126–135: The explanations on these pages are rather complicated, and, taken as a whole, are not teachable in the class-room. It would be better to point out for the teacher exactly the form to be used. Pp. 148–152: One is disappointed not to find a reference to the modern partial-payment problem most frequently met; namely, the one in which limited payments are accepted at stated intervals, usually at interest dates. Pp. 180–181: An expansion and illustration of this topic would be of greater value than the familiar material on pp. 172–175. Chapters VIII.–IX., pp. 196–233, are Herbartian and discuss the teaching process from the standpoint of the subject, instead of from the standpoint of the pupil. Pp. 200–201: The teacher's aim is relatively unimportant. It is the pupil's purpose that controls his activity. Consequently he must have a stronger motive than that suggested at the end of p. 201. In this connection, compare pp. 201 and 203 with the more helpful suggestions on pp. 212 and 218. Pp. 236–242: these lists impress one as more complete than significant. The points made need classifying. The young teacher should be told which of these are most important. It is better to study a few essentials of a model lesson, than to attempt so ambitious a list. Pp. 243–277: Chapter XI. is wholly inadequate, especially in its treatment of the curriculum. The vital question to-day is not, "How shall we parcel out the body of arithmetical science?" but, "What live issues, appreciated by children, shall we choose as the core of instruction?" The curriculum must precede method, hence the prospective teacher should be instructed to observe this order in teaching. Pp. 278–280: Since many of our normal students take one or two modern languages, a few references to foreign works on the teaching of arithmetic might be helpful, particularly the German works of Unger and Knilling.

The foregoing criticisms should not be taken as the estimate of the book. The volume is packed with good suggestions to teachers, and will take its place among the most useful half-dozen available books on the subject.

LAMBERT L. JACKSON

MONTCLAIR, N. J.,
January 3, 1914

Guide to the Study of Animal Ecology. By CHAS. C. ADAMS. New York, Macmillan. 183 pages.

This book is essentially a bibliographical and methodological manual for field students in ecology. As is stated in the preface the primary emphasis is upon ecological survey work. Thus instrumental measurement of the environment and experimental study are elaborated in the literature cited. The following chapter headings appear: Aim, Content and Point of View; The Value and Method of Ecological Surveys; Field Study; The Collection, Preservation and Determination of Specimens; Scientific Technique; Sources of Information on

Life Histories; Environmental Change; Metabolism, Growth, etc.; Adjustment between the Environment and Animal. Its scientific value lies in the author's outline for the organization of the science.

In the first chapter, the subject is divided into "individual ecology" or the ecology of individuals and species, and "aggregrate ecology," or the ecology of taxonomic groups of species, genera, families, etc. These two divisions have usually not been recognized separately. The distinction is good, but the two divisions taken together are coordinate with his third division, "associational ecology," or the ecology of communities. Chapters II.–IV. are devoted to ecological surveys and methods of conducting them. The author rightly deplores the tendency of museums to rate the work of collectors and expeditions on the basis of number of specimens brought back, as this discourages the recording of ecological facts. The methods of collecting, preserving and arranging notes and specimens, and securing proper identification of the latter are given. These chapters will be of material aid to those undertaking field ecological study.

Although divided under several chapter headings, the remainder of the book consists essentially of about 90 pages of classified bibliography. The references are of a diversified type and are intended to guide the worker to needed information, ranging from the making up of the sometimes necessary camping outfit, to the preparation of his results for the printer. They are classified under general headings and many are followed by statements as to contents. Representative papers on the environment, animal communities, struggle for existence, physiology, behavior and many other topics are included. The references are complete enough to give valuable suggestions to workers from almost any point of view in ecology. The comments on the more important older ecological papers make it clear that a considerable number of incomplete attempts at organization of knowledge of animal communities have been recorded. Thus by means of the references, the book gives the history of the development of the science.

V. E. SHELFORD

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SPECIAL ARTICLES

THE "GOLDEN MEAN" IN THE INHERITANCE OF SIZE

IN bulletin 242 of the New Jersey State College Experiment Station, page 39, appears the following statement:

> The size and shape of the F_1 (tomato) fruits are the geometric means between the size and shape corresponding to those factors of the parents, which were active in crossing.

This statement was based upon the measurements of many thousands of tomato fruits. A mode of inheritance in which $x(F_1) = \sqrt{ab}$ assumes that in the union of gametes representing factors for size a multiplication and the extraction of a square root take place. I was unable at the time to explain how that might occur, and so far no attempt by any one else to interpret the significance of my results has come to my notice. In a forthcoming bulletin I shall present details of F_2 and F_3, and this paper is published solely to set forth the nature of the principle of size inheritance by the "golden mean," to indicate its bearing upon vital questions on subjects in heredity, and to establish the priority of its discovery.

When two factors for different sizes of homologous parts meet in a cross, the resulting F_1 size is commonly intermediate in such parts as are not greatly subject to fluctuation. If a and b represent the parental size characters, it has been tacitly assumed by most investigators that the F_1 size is $(a+b)/2$. In tomato fruits I found it to be $\sqrt{ab}$. On the face of it the average (algebraic mean) seems the more probable, but when used as the basis for the comparable inheritance of lines, surfaces, and volumes, it becomes impossible. For example, let plants be crossed, which have spherical fruits of diameters a and b, and let us assume, for the sake of simplicity, that all cells constituting the volumes of both fruits are of equal dimensions. Then the ratio between parents and F_1 of the number of cells

forming any diameter one cell in thickness would be as $a:(a+b)/2:b$; the ratio between the cells making up the surface (epidermis) of the respective fruits would be as $a^2:[(a+b)/2]^2:b^2$; while the ratio between the number of cells constituting the entire volume would be as $a^3:[(a+b)/2]^3:b^3$, all of which ratios are different. It is evident, however, that any cell might be cut by a diameter and that the surface cells are part of the volume. The size inheritance of an epidermal cell might fall under either of these three ratios, depending on which aliquot part of the fruit was under study. If there is inheritance of the nature $x=(a+b)/2$, it is not clear why the diameters and not the surfaces or volumes should fall under that principle. If one does, the other two can not.

If it be assumed, under like conditions, that $x=\sqrt{ab}$, the ratio between parents and F_1 of the number of cells forming a diameter one cell in thickness becomes $a:\sqrt{ab}:b$; that between the surface cells $a^2:ab:b^2$; and that between the total cells in the volume of the sphere $a^3:ab\sqrt{ab}:b^3$. These three ratios are all equal to $a:\sqrt{ab}:b$, if a and b mean the respective parents, so that no matter what aliquot part of the fruit is under study, the ratio of size inheritance of lines, surfaces, and volumes would be the same. Surely this appears the more probable.

But how can a plant extract the square root of a product? For the sake of convenience in demonstration let us assume that the fruits are cubes instead of spheres, that all cells are equal and of size 1, and that parental characters of size are 4 and 9. Then the length factor of the F_1 would be made up of two forces, one tending to build strings of four cells in the direction of the longitudinal axis, the other tending to build strings of nine cells. Similarly, the breadth factor would be made up of two such forces building at right angles, and in the same way the factor for thickness at right angles to both. Constituent 4 of the length factor, coming from one parent and constituent 9 of the breadth factor coming from the other parent may then be imagined as building at right angles to each other, in strings of nine in one direction, in strings of four in the other. The respective partners of the two factors would be similarly engaged, and likewise the two length factors with those for thickness and the two breadth factors with those for thickness. Each set of two would tend to build rectangles of the dimensions $9\times 4=36$. If now there were some force stronger than the tendency of the size factors, which would prevent the formation of rectangles and permit only squares, while having no influence on absolute size, area, or volume, the sets of size factors would be forced to modify the shape of their structures, making squares instead of rectangles. Since the modifying force did not influence area, the resulting squares would also be of the area 36, their sides 6, and the cubical fruits $6\times 6\times 6=216$. This modifier of size is the factor for shape. When both parents carry only the factor for cubical shape, the F_1 fruits are cubical, no matter what the tendencies of the size factors.

In spheres the diameters are directly proportional to the sides of equal cubes; so that what applies to cubes in this respect, applies to spheres as well. The factor for spherical shape is the modifier of the interaction of the factors for absolute size.

At first sight it may seem as if the fact that the size of the F_1 is the golden mean between the parental sizes can be of little value beyond furnishing an explanation of partial dominance in the F_1. However, the recurrence of the action of the modifier (shape) upon the various size combinations in the F_2 interferes greatly with the chances for the appearance of certain visible size characters.

We know that size characters do segregate in the F_2, but we admit that with them the simple Mendelian ratio of 1:2:1 is never realized, though in large populations the parental sizes may reappear. Mendelians commonly try to account for the complicated ratios by assuming the presence of multiple factors; non-Mendelians point to the same ratios as quasi-evidence against Mendelian inheritance. I here offer a different explanation.

In the F_1 fruit $6\times 6\times 6$ the size character 6 is not the result of a factor for size 6, but of the three forces exerted by two size factors and

one modifier. It has not been assumed in the above explanation that the partners in an F_1 "factor" fuse to make a new factor. Thus we have to deal in both ♂ and ♀ gametes produced by the F_1 with factors 4 and 9 for each of the three size factors, length, breadth and thickness, occurring in equal numbers, and mating by chance (in self-fertilization). This is the same assumption made by Mendelians, even if they should not admit the F_1 inheritance of $x = \sqrt{ab}$. There would be these eight possible combinations uniting with each other by chance:

Combination	Length	Breadth	Thickness
1	4	4	4
2	4	4	9
3	4	9	4
4	9	4	4
5	9	9	4
6	9	4	9
7	4	9	9
8	9	9	9

These would result in the following 64 matings:

Mating	Resultant	Volume
1 × 1	4 × 4 × 4	64
1 × 2	4 × 4 × 6	96
1 × 3	4 × 6 × 4	96
1 × 4	6 × 4 × 4	96
1 × 5	6 × 6 × 4	144
1 × 6	6 × 4 × 6	144
1 × 7	4 × 6 × 6	144
1 × 8	6 × 6 × 6	216
2 × 1	4 × 4 × 6	96
2 × 2	4 × 4 × 9	144
2 × 3	4 × 6 × 6	144
2 × 4	6 × 4 × 6	144
2 × 5	6 × 6 × 6	216
2 × 6	6 × 4 × 9	216
2 × 7	4 × 6 × 9	216
2 × 8	6 × 6 × 9	324
3 × 1	4 × 6 × 4	96
3 × 2	4 × 6 × 6	144
3 × 3	4 × 9 × 4	144
3 × 4	6 × 6 × 4	144
3 × 5	6 × 9 × 4	216
3 × 6	6 × 6 × 6	216
3 × 7	4 × 9 × 6	216
3 × 8	6 × 9 × 6	324
4 × 1	6 × 4 × 4	96
4 × 2	6 × 4 × 6	144
4 × 3	6 × 6 × 4	144
4 × 4	9 × 4 × 4	144
4 × 5	9 × 6 × 4	216
4 × 6	9 × 4 × 6	216
4 × 7	6 × 6 × 6	216
4 × 8	9 × 6 × 6	324
5 × 1	6 × 6 × 4	144
5 × 2	6 × 6 × 6	216
5 × 3	6 × 9 × 4	216
5 × 4	9 × 6 × 4	216
5 × 5	9 × 9 × 4	324
5 × 6	9 × 6 × 6	324
5 × 7	6 × 9 × 6	324
5 × 8	9 × 9 × 6	486
6 × 1	6 × 4 × 6	144
6 × 2	6 × 4 × 9	216
6 × 3	6 × 6 × 6	216
6 × 4	9 × 4 × 6	216
6 × 5	9 × 6 × 6	324
6 × 6	9 × 4 × 9	324
6 × 7	6 × 6 × 9	324
6 × 8	9 × 6 × 9	486
7 × 1	4 × 6 × 6	144
7 × 2	4 × 6 × 9	216
7 × 3	4 × 9 × 6	216
7 × 4	6 × 6 × 6	216
7 × 5	6 × 9 × 6	324
7 × 6	6 × 6 × 9	324
7 × 7	4 × 9 × 9	324
7 × 8	6 × 9 × 9	486
8 × 1	6 × 6 × 6	216
8 × 2	6 × 6 × 9	324
8 × 3	6 × 9 × 6	324
8 × 4	9 × 6 × 6	324
8 × 5	9 × 9 × 6	486
8 × 6	9 × 6 × 9	486
8 × 7	6 × 9 × 9	486
8 × 8	9 × 9 × 9	729

Among the possible combinations there are 16 in which both ♂ and ♀ have furnished the factor for length 4, and it has been commonly assumed that therefore one quarter of the F_2

population should show the character of length 4. The column of volumes, however, shows that there is only one out of the 64 with a volume 4^3. All others with factors for length four have larger volumes, because their factors for breadth and thickness are greater than four. Here again the law of the golden mean is followed as all combinations bearing unequal size factors are forced to build cubes by the modifying factor shape. Evidently all matings resulting in equal volumes will make equal cubes and therefore show equal characters of length, breadth and thickness, though not necessarily possessing equal size factors nor even the factor for the size which they exhibit. If we group the results by volume and length of side, we have:

Volume	Instances	Side of Cube
64	1	$\sqrt[3]{64} = 4.$
96	6	$\sqrt[3]{96} = 4.57 -.$
144	15	$\sqrt[3]{144} = 5.25 +.$
216	20	$\sqrt[3]{216} = 6.$
324	15	$\sqrt[3]{324} = 6.87 +.$
486	6	$\sqrt[3]{486} = 7.86 -.$
729	1	$\sqrt[3]{729} = 9.$

That means that the chance for a parental size (whether line or surface or volume) to reappear is only 1 : 64 instead of 1 : 4. Moreover it is clear that each of the 8 possible combinations given on page 7, when mating with its like, will breed true to all three size characters, and continue to breed true thereafter if selfed. That means that these matings will form constant races, viz.:

Mating	Resultant	Volume	Size
1 × 1	4 × 4 × 4	64	4
2 × 2	4 × 4 × 9	144	5.25
3 × 3	4 × 9 × 4	144	5.25
4 × 4	9 × 4 × 4	144	5.25
5 × 5	9 × 9 × 4	324	6.87
6 × 6	9 × 4 × 9	324	6.87
7 × 7	4 × 9 × 9	324	6.87
8 × 8	9 × 9 × 9	729	9

Besides the parent-like strains then, we shall seemingly have two other races, one of volume 144, size 5.25, the other of volume 324, size 6.87, which will continue to breed true if selfed. Each of these strains consists of three gametically different, though visibly indistinguishable lines, which when crossed will give an F_1 equal to both parents, but segregating to some extent in the F_2. The finding in the F_2 or later generations of lines which breed true to size characters is thus not proof of the presence of multiple size factors in the original parents, etc.

In the bulletin in preparation I intend to discuss the bearing of the law of the golden mean upon the interpretation of inheritance of shape and number, mutants, latent factors, inhibitory factors, coupling and repulsion, factors other than those of size, shape, and number, and other points as they may come up, but for the sake of science I invite investigation into these relationships on the basis I here offer, even before I am able to publish the bulletin, which may not appear for several months.

B. H. A. GROTH

"THE LOWEST TEMPERATURE OBTAINABLE WITH ICE AND SALT"

FAHRENHEIT placed the 0° mark on his arbitrary thermometer scale at "the lowest temperature obtainable with ice and salt" or 32° below the freezing point of water, believing that water did not have a constant freezing point because of the undercooling which precedes solidification.[1]

While discussing freezing mixtures with a friend recently I stated that a temperature of − 19° C. could be *easily* obtained and maintained for some hours with an ice and salt mixture. My friend questioned the accuracy of the thermometer inasmuch as − 19° C. is below 0° F. (0° F. = − 17.78° C.). I have, therefore made a careful test to ascertain whether an ice and salt mixture may not show a lower temperature than 0° F.

About a gallon of finely chopped, hard, ice was mixed with a quart or more of coarse salt in a water-tight wooden box, the wooden box being used because of the insulation which it

[1] See Encyclopedia Britannica, 11 ed., "Heat," article 2.

afforded. The temperature was then observed with five thermometers:

Thermometers 1 and 2 were "nitrogen filled" thermometers graduated in Centigrade degrees ranging from — 29° to + 360° in 1° intervals. These are the ordinary high-grade laboratory thermometers.

Thermometer 3 was a small "Anchutz normal" thermometer reading from — 25° to + 50° in 1/5° intervals. This is one of the most accurate types of chemical thermometers obtainable.

Thermometer 4 was a large thermometer of the same type as No. 3, but reading from — 19° to + 360° in 1/5° intervals.

Thermometer 5 was an ordinary Six's maximum and minimum thermometer graduated in degrees Fahrenheit, each graduation representing 2°.

Thermometer 6 was a standard Weather Bureau type minimum thermometer reading from — 35° to + 115° F. in 1° ranges. This is probably one of the most accurate types of Fahrenheit thermometers obtainable.

Thermometer No. 6 was spirit filled. No. 5 contained a combination of spirit and mercury and all of the others were mercury filled.

Thermometers 1, 2 and 3 gave the same temperature for the ice and salt mixture, *i. e.*, — 21° C. which is the equivalent of 5.8° *below zero* Fahrenheit. Thermometer 4 was graduated only to — 19° C. and the mercury was some distance below the bottom of the scale. By interpolation a reading of — 20° to — 21° C. was made. Thermometer 5 gave a minimum of — 4° F. while the Weather Bureau thermometer (No. 6) gave a reading of — 5° F.

Previous to this experiment I had filled a wooden box holding perhaps 30 pounds of ice with a freezing mixture in the evening and placed it in an empty ice box to conserve ice. In the morning I noted a temperature of — 19° C. (— 2.2° F.).

From these experiments I am convinced that 0° F. is not "the lowest temperature obtainable with ice and salt." Just what the "lowest temperature" is I am unable to state, having failed to secure a greater lowering than — 21° C. Theoretically the lowest temperature should be the cryohydric point (— 22° to — 23° C.) where the cryohydrate, ice and salt containing 23.6 per cent. of NaCl, separates.

ROSS AIKEN GORTNER

THE AMERICAN PETROLEUM SOCIETY

THE American Petroleum Society was organized September 10 at the U. S. Bureau of Mines, Pittsburgh, Pa. This organization is the result of an effort of the bureau for the past seven years to bring together the men interested in the petroleum industry.

Invitations were sent out in July to the secretaries of twenty-four of the great national societies of the United States, inviting them to be present and to cooperate in this organization. Eighteen of these societies responded at a meeting on August 1 at the Bureau of Mines. A similar invitation was sent out in August to eight additional societies, making a total of thirty-two societies that were invited to attend the September conference. A large number of these were represented at the meeting on September 10, when the final organization was completed.

This society will concern itself with the study of all phases of natural gases and petroleums, including the origin, statistics, conservation, drilling methods, production, transportation, storage, refining and specifications for refined products.

When it is considered that each year, within the United States alone, there are produced crude petroleums and natural gases having a value in excess of $200,000,000, and that no society has ever been organized in America for their comprehensive study it is reasonable to suppose that the future of this society is assured. There is to-day a tremendous waste of natural gases which, by proper methods of drilling, could be prevented. Also, there is waste of crude oil due to improper methods of production and handling. The necessity for a critical study of petroleums and gases by the members of such a society is evident.

At the meeting on September 10 at the Bureau of Mines the constitution and by-laws were adopted, and officers were elected as follows:

President, C. D. Chamberlin, National Petroleum Association, Cleveland, Ohio; *Vice-president*, R. Galbreath, Independent Oil and Gas Producers' Association of Oklahoma, Tulsa, Okla.; *Secretary*, Irving C. Allen, U. S. Bureau of Mines, Pittsburgh, Pa.; *Treasurer*, Warren C. Platt, Independent Petroleum Marketers' Association of the United States, Cleveland, Ohio; *Acting Past President*, Frank B. Fretter, Western Petroleum Refiners' Association, Coffeyville, Kansas. In addition to the foregoing these members were also elected to serve on the executive committee: Ralph Arnold, Geological Society of America, Los Angeles, Cal.; C. F. Clarkson, Society of Automobile Engineers, New York City; G. M. Swindell, Chamber of Mines and Oil, Los Angeles, Cal.; Edmund O'Neill, American Chemical Society, University of California, Berkeley, Cal.; E. B. Rich, Gasoline Producers' Association, Parkersburg, W. Va.; George H. Taber, American Society for Testing Materials, Pittsburgh, Pa.

The first annual meeting will be held at New Orleans, La., October 16 and 17, 1914, and the second annual meeting will be held at the Panama-Pacific International Exposition in San Francisco, October 25 to 30, 1915. At the 1915 meeting it is anticipated that all of the petroleum societies in the country will meet in one great congress where many things of interest and of value will be presented.

An official invitation has been sent from the president of the Exposition at San Francisco to the president of the International Petroleum Commission, Karlsruhe, Germany, to hold the 1915 meeting of the International Petroleum Commission in San Francisco. This meeting will be part of the great meeting of the petroleum industries where the foremost petroleum technologists and scientists of the world will congregate. Plans are already being formulated for this great 1915 meeting.

Irving C. Allen

Bureau of Mines

THE AMERICAN BISON SOCIETY

At the annual meeting of the American Bison Society, held in New York on January 8, 1914, important action was taken relative to extending the work of the society by the passage of the following resolution, proposed by Professor Henry Fairfield Osborn and seconded by Dr. Wm. T. Hornaday:

Resolved, That the protection and propagation of the prong horn antelope be immediately undertaken by the American Bison Society in connection with its work for the buffalo, and that the board of managers be asked to request the president and officers to formulate and execute a plan whereby this purpose may be carried out.

At the annual meeting of the board of managers, after a brief discussion of this matter, the president and executive committee were instructed to take such action as they might deem best as soon as possible.

President Hooper, in his annual report, gave an interesting summary of the work already accomplished by the society, and pointed out several directions in which effort should be directed during the coming year. He called attention to the fact that when the society was organized some eight years ago only 1,100 pure-blooded bison were known to exist in North America, while on January 1, 1913, 3,453 animals were listed in the census compiled by the society, an increase of over 300 per cent. During the past year the Wind Cave National Game Preserve has been established at the instance of this society, and has been stocked with fourteen bison presented by the New York Zoological Society from its herd in the Bronx Park.

The work awaiting the society during the coming year was listed by President Hooper under three heads: (1) The establishment of a herd in Sully's Hill National Park, North Dakota, (2) the establishment of a state herd in New York state or elsewhere, (3) encouragement of the preservation of the prong horn antelope, and possibly of other species of big game animals.

Dr. T. S. Palmer, of the U. S. Biological Survey, called attention to the possibility of establishing a state herd in West Virginia on the preserve of the Allegheny Sportsmen's Association. He also stated that the Montana, Wind Cave, Niobrara and Wichita ranges were all well suited to antelope.

It was felt that the society could well take pride in its recent achievements, but that its efforts must not in any way be relaxed during the coming year.

William P. Wharton,
Secretary

SCIENCE

FRIDAY, APRIL 24, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y

THE PREDICAMENT OF SCHOLARSHIP IN AMERICA AND ONE SOLUTION[1]

WHAT is scholarship? The answer is: The discovering, the organizing and the explaining of new facts. Only the uninformed and unscholarly are in the habit of designating the mere diffusion of knowledge as scholarship. The man who merely reads and speaks what he reads is no scholar, nor is the man a scholar who merely requires others to study what is already known. Any nation that believes only in the diffusion of knowledge is on the road to decay. But it is not my purpose to prove the generally accepted notion that productive scholarship is the only scholarship. We must, however, agree on the value of scholarship or the argument in this paper can have no importance. That no one may say that our subject is idle talk, I want to say, I believe for any nation that has any hope of perpetual existence that the scholars are the most essential of any class of society. And may we postulate, for the sake of the argument, that God will not provide and take care of the scholars?

And what is the predicament of scholarship in America? Simply this: That the institutions that have attempted to foster scholarship have not lived up to their opportunities. We may inquire into the reasons later. The one solution that the author proposes is to establish a new and higher institution, whose sole purpose would be to promote scholarship, and thereby furnish a new inspiration to educational, industrial and private establishments.

[1] Read before the Outlook Club of the University of Iowa at the February meeting.

I shall confine my arguments to the one field of scholarship with which I am most familiar, and trust that my readers who are most familiar with other fields will notice the close parallelism to the predicament in physics. And perhaps to those also a solution similar to the one here proposed will seem advisable.

To avoid any tone of pessimism, the views of the author will be presented in a constructive way, with the subject-matter, a plea for the physical institute in America; this institute to serve scholarship in physics much as the physical institutes of the German universities, the Royal Institution of England or the Cavendish Laboratory at Cambridge serve scholarship.

America has not led in thought since the days of Franklin. America follows thought. Consider some of the recent achievements in physical science; X-rays and their nature, Hertzian waves, liquid air, liquid helium, cathode rays, positive rays, radium and radioactive bodies, alpha rays, beta rays, the construction of matter, the photo-electrons, the theories of radiation and of fluorescence, the relations of heat conductivity to electrical conductivity. These and practically every recently proposed fundamental principle and important discovery in modern physics has come from abroad. But it is not necessary to make any apologies in behalf of Yankee ingenuity. I am speaking only in behalf of basic knowledge.

A PLEA FOR THE PHYSICAL INSTITUTE IN AMERICA

In making a plea for the physical institute in America I am making a plea for greater efficiency in the development of pure science in this country. It is believed that the time is overripe for the segregation of a small group of the ablest scholars in experimental and theoretical physics, who shall have all the inspiration of close association with scholars in like work, all the facilities that an immensely wealthy country can provide, and who shall be free from the routine work of clerical management or the routine of teaching of disinterested or incapable students. The argument is simple and it is believed irrefutable, and is presented without in the least minimizing the value of a scattered scholarship for the general inspiration of a student body and the general public.

The time is believed to be overripe because we are spending more money on higher education per capita than any country of the globe, and at the same time it would be bold to claim a second-rate place for ourselves in the development of pure physical science. The situation generally in our universities is such as to discourage the development of capable and promising young men by management that encourages faithfulness to second-rate ideals. We are already on the verge of an over-production of zealous and promising scholars, who can see no future other than that of servitude in the small college or with detail or clerical work in a laboratory swarming with students. Admit if you will that it is all good work and also that the soul must do penance, nevertheless the bright and capable young man, even if he has a vision, insists on looking ahead to a life of respectability and achievement with an ultimate freedom from the worries of the things of life.

Our commercial enterprises are just discovering that much of this ability can be easily and most profitably adapted to the advancement of applied science. And it must be said to their credit that they already bid fair to surpass most of our universities in pure science, even though their ideal is admittedly to make scholarship pay in the near immediate future. The

wonderful success of some of our commercial research laboratories should furnish a genuine stimulus to those of us who believe in greater opportunities for pure science. Of course if we should not believe in a scholarship in science which is not hampered by questions of immediate rewards, then there is no occasion for the plea in this paper. A discussion of the organization and the scope of a working institute can best be given after we have first analyzed somewhat in detail the existing conditions which are manifestly not as efficient as they should be. And lastly, we should be in a position to outline a tentative plan for the development of the organization.

THE SITUATION IN OUR UNIVERSITIES

The idea of the physical institute is to supplement the work of our universities by founding a higher standard and furnishing a new source of inspiration. True enough, our universities have sufficient resources to properly foster the work of a physical institute, and there is an abundant supply of men forthcoming. Moreover, they believe in general that productive scholarship is the most important function of a university and it is agreed that genuine scholars are of the most rare and difficult type to develop. But the difficulty with our universities is one that arises from mixed ideals, particularly in our state universities. The ideal of competition perhaps takes precedence of all other ideals in practise, and along with this is associated the ideal of efficiency in detail management of students. Surely a university wants scholars, but it wants a large number of students first. It wants more students in order to convince the people of its greatness, so that it may get more money so that it may establish more departments, and so get more students, and so on. It must do extension work so that the work of scholars may reach every citizen of the land within a few days after it has been accomplished. Energy and resources that might be directed toward scholarship are scattered in every direction that human imagination can conceive of. The ideal in practise is not how great scholarship, but how thin can it be spread. In other words, there is in our scholarship a strong tendency toward democracy gone mad. Now if only one side of the situation in our universities is emphasized, may it be remembered that the author wishes to make clear a difficulty which can be side-stepped in one particular by the organization of the physical institute. Of course the administrative authorities of most universities would remind us that they are building for the future. Their ideal is service in a broad sense. Scholarship first in so far as it is first in service to the immediate mass of humanity. Scholarship for the sake of scholarship—never! But if we will admit the result of the recent investigations of Professor Cattell, which is that our administrative officers generally can have no vision of the value of scholarship to the future of society, we can proceed with our argument. The argument of the administration against scholarship is much like that of one farmer toward the education of his son. No, no, my son, you must stay out of school a few years and safeguard the future. We will raise more corn and feed more hogs, so that we can buy more land, and raise more corn, etc., and by and by you can go entirely through the university and take your brothers and sisters along if you yet have the desire.

The predicament of the state universities is well stated by Professor Geo. J. Peirce:

The masses of a democracy recognize present wants more surely than they anticipate future

needs. They require an immediate supply to meet an existing demand. They consider a state university to be well fulfilling its function if it furnishes such a supply. . . . But the wholesale business of the state university limits if it does not prohibit that attention to the exceptional student which may result in training a leader of his generation, a seer who, divining the future needs of the state, may begin to prepare to meet them, a man who, profiting by the recorded experience of the past, may mold as well as meet conditions.

And what has been the result of the material growth of our universities on the development of physical science in this country? We have laboratories of marble and cases filled with apparatus, and hordes of students, and a wonderful machine-like system to care for these students. But the efforts and resources adapted to scholarly purposes are not at all in proportion to merit. Even now we are confronted with a difficulty which shows us the need and opportunity of concentrating our efforts toward scholarship. Every year we have young men of good promise who either can not find positions at all in our universities, or who are compelled to take positions with such requirements and surroundings that the development of the individual is practically impossible, and at the same time every year the universities can not find enough mediocre men at salaries ranging from $600 to $1,000. The demand is for men who will take care of these hordes of students, men who will lead these students by the hand and feed them with a spoon, men who will set up elementary experiments, grade notebooks and daily examination papers, and correct English, and who thereby make parents and patrons believe that everything is moving along smoothly and efficiently. For if the students do not appear to be busy the institution will get a bad name and the number of students will not increase. And what can be worse than an idle student body or a lack of increase of students. It is no doubt true that in some instances scholarship is not developed in physics because the members of the department staff are beyond hope of becoming scholars and they either have no knowledge of what tends to develop scholarship or are afraid that some individual might develop who would be a greater man than those on the ground floor. But this latter is pure hypothesis.

What is needed is a higher light on American soil. Too many professors are satisfied to spend their time making out and mimeographing notes and examinations, and even making apparatus, or in conferences with the laggard students, or perhaps with unimportant committees. Sometimes they do not realize how poorly they invest their time when they are merely reading and becoming informed, as it were. Frequently professors keep themselves so busy with labors like the above and even such cheap labor as dusting apparatus that they do not have time and energy left for the merest semblance of thought. Productive scholarship is the flower of our educational work and that individual who shows tendencies to bloom should be allowed the every ounce of his energy to apply in this direction.

I believe it is not fair to blame the ruling bodies of our institutions too much, for they are merely the creations of a complex set of circumstances in our overemphasized democracy. Men with ideals when in power find themselves faced by situations which seem to require a single line of procedure in order to preserve any semblance of power. The reader will please not understand that our universities are devoid of good administrators, or that scholars are unknown. Moreover, there are evidences of forces at work for the improvement of our administrative methods in the universities, and there are urgent appeals for the improvement of scholarship. But I be-

lieve that the progress can be made more rapid, and that scholarship in theoretical and experimental physics can be more quickly put where it should be by the development of a new and higher institution, which shall be largely unhampered by the accustomed administration and students of our universities.

And I can not proceed further without saying a familiar word about our students. The students in our universities may be divided into three classes, as follows: those who early in their university career think they know how they wish to function in society and who remain in the university primarily as an aid to carrying out serious purposes—those who attend the university for a pleasant life and ultimate social standing primarily, who, like Micawber, trust that something will turn up—and those with a serious desire to specialize in some line of human activity after they have obtained some notion of the relative merits of the various classes of activities and their own fitness and interest.

Those of the first class constitute a large portion of the students of our professional colleges. The average brightness and capability of this class is very good. Perhaps this is because of the definiteness of procedure, and the assurance of a life of comfort and respectability. Perhaps some are afraid of being classed with the non-serious, purposeless ones and again some do not trust themselves to a broad career with its many chances and pitfalls.

The second class are the most numerous generally. They sometimes study elementary physics, and they usually get some good as a result of their sojourn in the university. No doubt the average of society is raised. Some who come to scoff remain to pray. The only objection to this class of students is that they are not worth their cost. Of course they can not be eliminated because of the difficulty of discerning who belongs to this class and because of the political dangers. The students of the third class are all too few in number, and of this class the contamination by the other classes is so great that the net weight is frequently vanishingly small. From this third class we should draw our scholars in all fields of pure science and the humanities, our artists, our administrators in many fields, including senators, representatives, college presidents and leaders, wherever there is a fight between the old and the new, because forsooth these men should view human activities in the broad sense, and therefore should recognize what efforts conform to the development of society and the universe.

Now the great criticism that a physicist in particular may bring against our universities is that the cream of the time and energy of the university professor is taken in contact with students of classes one and two.

THE SITUATION IN OUR INDUSTRIES

And what is the situation in our industries that we should declare that it is impossible for industrial research laboratories to properly develop science, no matter how much wealth and energy they may expend for investigation. In order to answer this question we may inquire into their ideals and methods, their resources and their achievements.

The ideal in our industries is admittedly investigation that pays, *i. e.*, investigation for a useful purpose. Now, as Dr. Whitney points out, the pay comes in two directions—one in returning more dollars and cents than is invested in the research laboratory, and, secondly, in maintaining the practise of the manufacturing concern by being ready to cope intelligently with any other concern that may attempt supremacy as a result of new discoveries. It may be unfair to pronounce upon the question as to whether there is a soul in a commercial enterprise that leads it to desire to achieve

for no other reason than to keep its name and its work preeminently on the map throughout the ages. Perhaps this latter phase of the ideal may exist even though its workers may be largely unaware of it. At any rate, I believe it is generally admitted that it is desired that material rewards shall be forthcoming in the near future. If it could be that wise leaders in industrial research could recognize the value of pure science to the industries centuries hence, then there would be not so urgent a plea for the physical institute. But these concerns are of human hands and in a democratic country, and the resources generally come from individuals who expect dividends at least in due time to be incorporated in the death wills of the stockholders. I believe that as a corporation grows large it tends toward the recognition of values other than immediate money values. If so this is cause for larger faith in humanity. In fairness we must also recognize the struggle for corporate existence the same as we recognize the struggle of the individual. It is, for example, perhaps difficult to know to whom should be given credit for the establishment of such able and broad-minded leadership as prevails at the General Electric Company's laboratories.

The pure scientist believes that it is most difficult to obtain willing and capable men who will devote all their energies to the search for new knowledge by the free and methodical movement of the human mind, without regard to practical applications and money rewards. He believes further that this is the only royal road to intellectual achievement, and yet he is not unmindful that some time or other much of the knowledge will be absolutely necessary to the existence of the human race. He believes that the man who investigates with a commercial purpose in view has a handicap load that must limit him in his arduous search to the extent that such an investigator can only be half a scientist.

The attitude of the commercial scientist may be gathered from the words in part of Dr. Arthur D. Little in his recent presidential address before the American Chemical Society:

> Most of us believe that the doctrine science for science's sake is as meaningless and mischievous as that of art for art's sake or literature for literature's sake. These things were made for man, not for themselves, nor was man made for them.

The pure scientist is perfectly aware of the immediate value to humanity of this attitude, but at the same time he insists that there should also exist a body of most capable thinkers who shall not be limited by placing dollar signs ahead to mark out the paths. Even from the standpoint of service the dollar mark often leads away from the best route or the safe route. For what man of Faraday's time could have predicted that within a century the electrical industries of one country would be facing a capital requirement of $8,000,000 a week.

That research pays our industries acknowledge fully. They are aware that in farming alone investigation has resulted in the saving of about $1,000,000 in the labor cost of a single crop and a very much larger saving as a result of increased yield, as compared with fifty years ago, or that in electric lighting alone fully the same sum has been saved annually as a result of the progress in the last ten years. And I doubt if it could be estimated the returns that have come to the steel industry or the telephone industry as a result of their years of special researches. According to Dr. Little there are several industrial firms that are now spending $300,000 annually on their research laboratories, and many more, $100,000 a year. These figures should certainly make those interested in the promotion of pure science take notice. It is perfectly obvious that it is a concentration of effort and resources of our much-talked-of trusts that has made possible these wonderful expendi-

tures and the advances which have followed. As a result of cooperation of several firms we have the National Electric Lamp Association Physical Laboratory at Cleveland, which perhaps approaches more nearly to a pure-science laboratory than any that are fostered by the industries. But this laboratory can not divorce itself from the interests that nourish it. Its investigators will naturally have regard for problems which seem to bear on the industry.

Also there is the Bureau of Standards, whose good work is so well known. This bureau spends annually about $700,000. But the spirit of this institution is toward the refinement and the standardization of the best that has been or about to be accepted in the scientific world. The scientists of this bureau are in a sense the conservers of scholarship. It is only occasionally that they expend energy toward the development of pure physics. They find plenty to do in the field they have chosen. It is very doubtful if this organization with its congressional control and red tape would be conducive to the free and easy movement of the human mind in scholarly productions.

In this connection the opinion of General A. W. Greely is worthy of note, which is:

> The failure of our government to properly recognize scientific work appears to be due to an antiquated and inherited policy, which must be to the ultimate detriment of the common weal. This year the attention of the government has been urgently called to the untoward conditions, arising from illiberal treatment of expert officials. Distinguished chiefs of several important national bureaus officially report increasing difficulty in maintaining an efficient scientific staff. Unusual and steadily increasing numbers of scientists and experts are accepting commercial positions in order to meet the enhanced cost of living.

THE ORGANIZATION OF THE PHYSICAL INSTITUTE

The organization of the physical institute should be such that a few of the greatest world physicists could be induced to join it and remain with it. The things that such a man needs are freedom from cares concerning food and shelter, livable surroundings, human associates who are interested in like work, and freedom from petty administrations, and perhaps the last two would be most effective in retaining men and keeping them effectively at work. Our universities and government bureaus frequently furnish the first two requisites, but seldom the last two. If any furnish all four, I shall let those who know say it.

The first condition would perhaps be filled satisfactorily if the physicists could have a salary of $10,000 each. The surroundings should be a laboratory fully equipped, situated preferably in some quiet spot and beautiful and within easy reach of some metropolis. Nearness to some large university would also be helpful.

The associations would be partly supplied by the other men of precisely equal standing at the laboratory, but this would not suffice for the men or the cause. There should be a number of fellows of standing about equal to that of our best new doctors of philosophy. They should obtain stipends of about $1,500, and should be allowed to keep these appointments for as many years as they see fit, of course devoting their time to research, with all the aid that they can obtain from the honored physicists, or honored professors, if you prefer. Also there should be as many students in theoretical and experimental work as the honored professors might wish to accept.

The administration should be entirely in the hands of these professors, who may elect a qualified secretary to take care of the routine business management. Any new appointments to the professorships or fellowships should be made only in case of

deaths or voluntary removals. No alteration should be made in the salaries or the essentials of the organization except by unanimous vote of the administration. The institution should be conservative, so that there might be no occasion for troubles and so that there might be ample time to test the ideal of the laboratory.

The institution should have the power to confer a special honorary degree on any man of the institute or elsewhere for preeminently noteworthy work in physics. This degree should bear no relation to the period of service of the candidate. This would aid in giving the institute a rightful leadership in scholarship.

An American institute for physics with the ideal for scholarship alone, should be fostered by private endowment, by a governmental bureau or by a national university, but hardly by any university such as exists already. A private endowment would be preferable from all points of view save perhaps one, providing of course that no strings were tied to the endowment inconsistent with the ideals of the institution. A privately endowed institution might not tie itself up with our nation and our existing educational institutions as fast as if it were otherwise fostered. And yet the success of the Rockefeller Institute for Medical Research would tend to dispel this notion. The capitalization need not be beyond a private endowment, for the income could be less than that spent by many industrial concerns on research, but of course more than spent by most universities for research.

A governmental bureau might foster such a project if it could only have a charter that would insure it a semi-permanent freedom from disturbances arising from the petty rules prevailing generally in our governmental bureaus. Such an action by our government would create a tremendous sentiment in favor of scholarship throughout our democracy. It is not unreasonable to expect that national support of scholarship would create a national spirit somewhat like that in Germany, for it is well known that the government there has long fostered scholarship and that German industrial supremacy has come as a result of supremacy in productive scholarship. According to Professor Mann, Germany has established a separate lot of schools to take care of the technical education which our state universities feel called upon to provide for.

The government might cooperate in a physical institute somewhat on the basis of the work done by the Carnegie Institution. Already this institution serves purposes closely akin to those of the proposed physical institute, particularly in geo-physics and in terrestrial magnetism, and yet there are obvious distinctions.

A national university might foster a physical institute properly, but there are grave doubts. It is not clear how such a university could be founded on federal support without the injurious meddling of the demagogue, who can not recognize any good to society that is not certain to extend to the masses in the present or near future generations. The attitude of Willet M. Hays, for example, who holds that a national university should reach ninety per cent. of the people in the present generation, may be all right for a technical school or high school, but this attitude should be regarded as positively vicious when applied to a national university. As the Assistant Secretary of Agriculture points out, already applied science is developing much faster than pure science. My opinion is that this only emphasizes our great need for institutions that shall develop leaders and prophets. Such an institution could, if properly chartered, in-

corporate a worthy physical institute. And this institute could pilot the way in those things that pertain to the development of physical science. A reasonable number of promising sudents would furnish working material for the honored professors, and later they would spread the gospel.

The publication of the work of such an institute would be a matter of detail and one that would take care of itself. I believe that a suddenly created national university with the proper ideals is an almost Herculean task. However, if several institutes of the character of the proposed physical institute could be founded one by one, these could later form a loose union for cooperation without waste of energy or loss of spirit.

If my readers are inclined to admit the strength of the argument in this paper when it is considered in connection with the efforts of our state universities, but not when considered in connection with our endowed universities, they should be reminded that the latter type of institution has not succeeded in retaining such physicists as Rutherford, Jeans, Richardson and Maclaurin. Other foreign physicists have even declined to try our atmosphere. Our self-respect demands that we attempt to create one center of physical research to which eminent world physicists would be willing and happy to come. I believe that with the establishment of the physical institute we should soon have the spirit, intelligence, work and courage of the American university professor in physics raised to such an extent that men would be honored with salaries as well as with ranking titles, such that the fellowship of students would mean inspiration rather than a deadly burden, such that irregular administrative management would not be tolerated, and such that a correct public sense of values would be established.

F. C. BROWN
THE STATE UNIVERSITY OF IOWA

THE NEW MECHANICS

IN the past decade, rumors have become current that physicists were attacking critically the ideas which have been accepted in mechanics since the time of Newton. Articles have appeared which assert that there are two mechanics, the Newtonian or classical, and tho non-Newtonian or modern. And it must occur to many to ask whether this is to be a war of words, as has so often resulted from looking at the same thing from opposite sides, or whether we are living in a world perplexed by two rulers, for we have pretty generally submitted to the doctrine that we and the rest of the universe are parts of a mechanical machine. And it would be an additional perturbation, in these already troublous times, to have to decide which governor to live under. While the laws of mechanics will probably be modified, still we are now certain that the changes will not affect problems involving matter in any of its ordinary aspects. The human race, in its present state of existence, will thus continue to conform to the laws of Newtonian mechanics; but we must be prepared for an early proclamation from Sir Oliver Lodge, the apostle of the science of spiritual mechanics, that death is merely the transfer of those complexes of the ether, called man, to a massive empty space governed by the laws of non-Newtonian mechanics—where our spirits move hither and thither with the velocity of light, and think with an energy comparable to the explosion of an atom.

The real issues of this very important discussion of the laws of mechanics are now fairly determined, and when the Société Française de Physique made them the subject of a conference, no one could have been found better fitted to state the case than M. Paul Langevin, of the Collège de France. Now that his opinions have been published, it is comparatively easy to present the ideas

underlying the new mechanics as a survey of his article.[1]

M. Langevin begins his discussion with the statement that the idea of mass has been the fundamental concept of mechanics since the time of Newton, and that it may be introduced in three different ways which correspond to three aspects of inertia. We may define mass as the coefficient of proportionality of force to change of velocity as derived from the formula, force equals mass times acceleration ($F = ma$); as capacity for impulse or quantity of motion, from the formula, momentum equals mass times velocity ($G = mv$); as capacity for kinetic energy, from the formula, kinetic energy equals one half mass times velocity squared ($w = \frac{1}{2}mv^2$).

Rational mechanics, to be consistent, requires that there must be perfect equality among these three definitions of mass, and that the mass of any portion of matter must remain absolutely invariable for all velocities and for all changes of the body, whether due to physical, chemical or mechanical agents.

By inertia we ordinarily mean the property which matter possesses of tending to preserve its state of rest or of uniform motion in a straight line; that is, matter resists any change of motion in such a way that an external action or force is necessary to change the quantity or the direction of a motion. Newton based mechanics on this constant proportion between force and change of motion, or acceleration; and he defined mass to be the constant of this proportion. He thus assumes that mass, determined in any other manner, will give a consistent result with his definition.

And since the time of Newton, every treatise on physics has begun with this assumption, that inertia is the fundamental property of matter, in the sense that it can not be expressed in simpler terms. Indeed, for more than two centuries, it has been held to be the essential doctrine of mechanics, that a physical phenomenon was satisfactorily explained only when it was reduced to a type of motion governed by the laws of this rational mechanics, and particularly by the law of inertia.

But now, after a searching criticism of the postulates of mechanics, many physicists have come to the conclusion that inertia is not a fundamental property of substance, and they claim to have proved that it can be reduced to simpler terms by the laws of electromagnetism, which show evidence of being simpler and more fundamental than the laws of dynamics.

First, because it can be proved that inertia is not invariable, since the quantity of mass, as measured by the three definitions given above, ceases to be the same when the velocity of matter is not small compared to the velocity of light.

Furthermore, although for small velocities the three definitions of mass agree and assign to a given portion of matter a definite initial or "stationary" mass, m_0, yet even this initial mass depends on the physical and chemical state of the system and also varies for each change of state which is accompanied by an interchange of energy with an outside body.

This evidently means that, if a body radiates heat, light or electro-magnetic waves to other bodies, or if a body unites with another to form a new chemical compound, then the mass of the body in each case changes. The relation between this change of mass and the change of energy is found to be a very simple one, as the change of mass equals the change of energy divided by the velocity of light squared, or

$$m - m' = \frac{V^2}{w - w'}.$$

It follows because of the law of the conservation of energy that in a system of bodies whose separate parts mutually exchange energy, the masses of the separate parts vary, but the total mass of all the parts added together remains constant, if the system as a whole does not change its total quantity of energy. Thus the law of conservation of mass is merged into the more fundamental law of conservation of energy.

The inadequacy of mechanics became apparent when physicists attempted, without success, to explain electro-magnetic and optical phenomena from the accepted mechanical laws. We now see, as Professor Einstein has shown

[1] P. Langevin, "L'inertie de l'énergie et ses conséquences," *Le Journal de Physique*, July, 1913.

by the principle of relativity, that an essential error was introduced when the formulæ of dynamics and those of electromagnetism were assumed to lead to the same conceptions of space and time. According to the new mechanics, our ideas of time and space, obtained from mechanical notions, are only approximately true, while those derived from the laws of electromagnetism are correct. The result is many physicists of the new school are now seeking for an interpretation of inertia from the laws of electromagnetism rather than to continue to explain the laws of electromagnetism by mechanics. These laws of electromagnetism have the advantage of great simplicity of form which may qualify them to serve as the fundamental principle of all physical laws.

The germ of these new views of electromagnetism is to be found in the work of Faraday and Maxwell. Their true experimental foundation is Rowland's experiment, performed in 1878, when he found that an electric charge, if it be carried through space with a high velocity, acts like an electric current in that it creates about itself a magnetic field. Three years later, J. J. Thomson showed that, if an electrified body moves through space, it not only creates a magnetic field in the surrounding space, but also that this magnetic field is a form of mechanical energy; from the law of the conservation of energy, this energy must be acquired at the expense of an equal amount of energy localized in the free space about the body. Now it can be shown rigorously that this "magnetic" energy has all the characteristics of a kinetic energy, since it is proportional to the square of a velocity and contains a factor which corresponds with the mass as given in the third of our former definitions. This supplementary inertia of electromagnetic origin results solely from the fact that the body is electrified, and it is an addition to the stationary or initial mass which was denoted by m_0.

The result is the same if we consider the second definition of mass, as a capacity for impulse or momentum. So soon as a body is electrified and moves, it develops a supplementary capacity for momentum which agrees with the supplementary capacity for energy which has just been described. Poincaré, in order to preserve the fundamental law of the conservation of momentum, has shown that it is necessary to localize a quantity of momentum in space just as we were forced to localize a quantity of energy in space. Thus the fundamental consequence of rational mechanics, requiring the three definitions of mass to agree, is not satisfied for all cases of motion.

These ideas have affected our notions of space. Maxwell deduced as a consequence of theory that rapid and periodic variations in the electrical charge of a body should be propagated through space with the velocity of light. The existence of these electromagnetic radiations was verified experimentally by Hertz, and in the hands of his successors this new form of radiation has attained great importance under the name of wireless telegraphy. A theoretical consequence of this radiation is the now generally accepted belief that light is merely a type of electromagnetic radiation of excessively rapid vibration. To transfer the phenomena of light from a mechanical to an electromagnetic manifestation of energy was to shake profoundly the belief in the fundamental and universal nature of mechanical energy.

Another very important principle of rational mechanics was embodied in Newton's third law of motion, that to every action there is an equal and oppositely directed reaction. But we have not been able to make the forces created by an electrified body in motion conform to this law. This is especially evident when radiation also occurs. Let us suppose that an incandescent body is giving off light (*i. e.*, electromagnetic radiation) uniformly in all directions. By reason of symmetry this radiation exerts no resultant force on the source. But if the perturbation, in the form of a wave, encounters an obstacle at a distance, then we know, both from theory and from experiment, that the obstacle will be subjected to a force due to its absorbing a part of the radiant energy. This pressure of light pushes the obstacle in the direction of the propagation of the light, and the action thus exerted on the

distant body is not compensated by a reaction appearing at the source or on any other portion of matter. We thus have cases of actions without reactions, if matter alone is considered.

It must be clearly understood that the discrepancies involved in the results of the rational mechanics, which have been cited, do not become appreciable except under unusual conditions. We can still consider mass as an absolute constant and the equations of dynamics as exact, unless matter has a velocity exceeding 18,000 miles a second, or for changes of state which involve enormous quantities of energy, such as those associated with radioactive bodies or those which accompany the formation of the chemical atom. At the present day we have made no progress in attaining any of these conditions, for even in the case of radio-active bodies we should need to find a method of liberating their energy in hours rather than in hundreds of years. Thus the problem would have remained academic, if theorists had not advanced the hypothesis that electricity is atomic in nature and that the electron, as the least portion of electricity is called, ordinarily attains a velocity which does exceed a velocity of 18,000 miles a second; that radiation must be explained as a transfer of an entity, energy, through space; and that the chemical atom of the radio-active elements decomposes spontaneously and of all other elements is theoretically decomposable with the evolution of an enormous amount of energy. All of these theoretical cases would make the discrepancies between the laws of mechanics significant.

It would exceed the limits and the purpose of this article to attempt to follow M. Langevin in his exposition of the properties of electricity and of matter, of inertia, of radiant energy, and of the principle of relativity. After all, these abstruse questions are proper for the discussions of specialists as they deal with the nature of matter in a state quite outside the limits of observation. But however the hypotheses of electrons and the ether may impress the world as being matter of definition and words rather than of substance, yet from them follow conclusions which can be tested experimentally. And the conclusions to be drawn from the new mechanics are interesting.

For example, from the assumption that the mass of a body varies when it gives out heat or light, we must conclude that if a pound of water at 32° Fahrenheit were heated to 212°, its inertia or mass would be greater. Unfortunately, when we calculate the increase of the mass for this or for any practicable heating of a body, we find that it is entirely too small to measure.

Again, let us put a known mass of hydrogen and oxygen in a closed vessel and cause them to unite to form water. Since the union of these gases liberates an immense amount of energy in the form of heat which will be radiated from the walls of the vessel, the mass of the water must be less than the combined masses of the two gases. But unfortunately again, the calculated decrease in mass is only a five-billionth part and thus entirely too small to measure.

Lastly, the radio-active bodies give off an amount of energy much greater in proportion to the mass acting than can be obtained by any chemical or other process. We might hope to measure the decrease of mass in these cases, but we can not, because these bodies give off their energy far too slowly.

Such, in the main, is M. Langevin's exposition of the new ideas in mechanics. There is not the least doubt that this rigorous searching of the classical mechanics has been a most important advance in science, and we are certain to find its laws must be revised in order to make them conform to the more rigorous exactness which is now required of mathematicians. But it is equally certain the laws of mechanics have withstood this criticism extraordinarily well, in so far as they have been unshaken when we are dealing with motions which can be attained by bodies of sensible mass.[2]

[2] That is, Newton's laws of dynamics are rigorous when bodies of tangible size, acting in measurable spaces and times, are investigated. They are approximations for exceptional cases; in much

The divergence of the new and the old mechanics occurs only for actions of separate electrons, of unattainable velocities, of energy existing in the chemical atom, and of radiant energy in empty space unassociated with matter. Now there are many men of science who think these problems are metaphysical, in that they do not deal with measurable bodies or with phenomena capable of experimental verification. And there is a great likelihood that problems of such a nature are incapable of scientific solution and are apt to drift into a discussion more of definitions and of words than of objective facts.

The warning which was given by Poincaré, shortly before he died, is one to be heeded by the over-zealous.

> If, however, in some years, its rival (the new mechanics) triumphs, I shall venture to point out a pedagogic error that a number of teachers, in France at least, will not escape. These teachers will find nothing more important, in teaching elementary mechanics to their scholars, than to inform them that this mechanics has had its day, that a new mechanics where the notions of mass and of time have a wholly different value replaces it; they will look down upon this lapsed mechanics that the programs force them to teach and will make their scholars feel the contempt they have for it. Yet I believe that this disdained classic mechanics will be as necessary as now, and that whoever does not know it thoroughly can not understand the new mechanics.

Louis T. More

University of Cincinnati,
December 3, 1913

GEORGE WESTINGHOUSE

My acquaintance with Mr. Westinghouse commenced in the spring of 1867 in Pittsburgh. He was at that time introducing to the railroads a patent car replacer and a double-headed railroad frog, both of his invention. These were being manufactured by Messrs. Anderson, Cook & Company, crucible steel manufacturers, I being employed by the same company. He was doing the selling—at the same time making his first acquaintance with railroad men, so valuable to him in later years. We lived at the same hotel and later on, after we were both married for about a year, we lived in the same house on Penn Avenue, next door to where the great Westinghouse Building now stands, and, being of congenial tastes, our acquaintance ripened into a warm friendship which continued up to the time of his death.

During this time he often talked of the idea of operating the brakes of a railroad train by compressed air, one of the greatest advantages of which he thought would be the putting of the full control of all movements of the train into the hands of the engineer. He had witnessed a collision between two trains and saw the necessity of some better apparatus for controlling their speed than what was then in use. Not having the money to pay the expense of the first equipment, which only amounted to $750, he gave a very substantial interest in the patent to one of the men who was afterward associated with him, in return for the necessary capital. This gentleman made over $2,000,000 out of this interest in the Brake Company within the next twenty-five years.

He soon had all the details of the new invention worked out and the first train equipped. It was first tried on an accommodation train on the P. C. & St. L. Railroad, running west from Pittsburgh. It was a success from the very first, preventing a bad wreck and probably saving several lives within a week after its installation.

A company was soon formed and the manufacture of the brakes was commenced within a few months. He added from time to time improvement after improvement until in 1886 he brought out the automatic quick-action brake. The greatest rival of the air brake at that time was an electric brake. After studying this problem for some time, Mr. Westinghouse announced to his associates that he had conceived the idea of an improvement in the air brake that would make its operation quicker than the electric. No one could understand how this could be true, but when the brake was constructed and put in operation they found it was a fact.

the same way as his more universal law of gravitation is accurate for ponderable bodies but fails for intangible molecular bodies.

The results of the working of this improvement proved that it was very much superior to the older form and that his claims were correct. The company then equipped a 50-car train with the improved apparatus. This was taken all over the continent from Boston to San Francisco, giving exhibitions at different points.

This settled the question beyond any doubt as to which was the best brake, and nothing more was heard of the electric brake, until the latest invention by Mr. Westinghouse within the last few months of the electric pneumatic, which is, as its name implies, a combination of the use of electricity and air pressure.

He early turned his attention to railroad signaling and was the father of the modern automatic signal, first using compressed air and later electricity and a combination of both.

The inventions of Mr. Westinghouse have done more for the safety of the railroad traveling public than those of all other inventors that have ever lived. People who travel will never know how much of a debt they owe for their safety to him. The fact is that to-day the safest place for a man to be is on a railroad train. This is proved conclusively by the fact that accident insurance companies pay double the face value of their policies if the death of the insured occurs on a public conveyance.

I think that the invention and development of the air brake was Mr. Westinghouse's greatest work. It certainly has done more in saving lives and making travel safe than all other inventions put together. The present generation can never know how much it means to them, but they will remember the name of Westinghouse more in connection with the air brake than anything else.

Mr. Westinghouse was quick to grasp the possibilities of any great invention or enterprise. This was shown in his development of the use of natural gas in Pittsburgh. The iron manufacturers of Allegheny County had been watching the use of this wonderful fuel by one mill for 15 years, all of them saying that it could be only temporary and would soon give out. After Mr. Westinghouse's attention was called to it and he began studying the subject, he made up his mind that the supply of natural gas was immense and would last long enough to warrant the organization of a large company for its development and distribution. He, therefore, organized the Philadelphia company and in a few months had Allegheny County literally ablaze with the gas from many wells and was supplying the mills and private residences with the new fuel at a price which saved them millions of money besides paying handsome dividends to his stockholders.

To him more than any one else in this country is due the development and introduction of the alternating electric current. The story of its introduction in this country is well known, having been told by better pens than mine. The extent and magnitude of his electric and machine works far surpass any of his other enterprises. At the time it was built the floor space covered by the British Westinghouse Works at Manchester in England was as much as the combined Westinghouse electric works and the Westinghouse machine works in East Pittsburgh.

George Westinghouse had unlimited faith in himself and he had the courage of his convictions. He never asked his associates or the public to invest in anything in which he would not risk his own money. All of his stockholders could be dead sure of always having a square deal from him.

A frenzied financier once made a proposal to him which involved the sale of a company whose stock he controlled. The scheme as proposed by this man was that the stockholders were to get one price for their holdings while Mr. Westinghouse was to receive a much larger price for his. His reply was one of the most indignant, scathing and cutting letters that I have ever read and must have been anything but pleasant reading to the receiver.

It is given to very few men to be responsible for the creation of such great enterprises as those which were founded by Mr. Westinghouse, and he was justly very proud of them and of what they had done—but more than all else

for what they had done for humanity, especially in the introduction of the air brake.

We who knew him best were very proud of him and could not but love him, and for that reason we could have wished that he had devoted less of his time and energy to his enterprises in Europe and more to those on this side of the Atlantic. He would have had very much less worry and more peace of mind and comfort during the last few years.

He had a dream of seeing all of Great Britain's system of railways electrified. He thought the time had arrived when it could be done. This was his reason for the erection of the great works at Manchester, but he was a little ahead of the times. England is an ideal country for such a possibility, a network of railways, an immense number of short light trains, and coal mines so near that it would be quite within the range of developed possibilities of to-day to have the electric current generated by gas engines at the mines and distributed all over Great Britain by the high-tension electric system. None of the lines would have to be more than 200 miles long, most of them much less.

There are several schemes to erect monuments to the memory of Mr. Westinghouse. There can not be too many, or too costly; but after all the greatest and grandest monuments are the ones he built himself—the great works all over the world employing some sixty thousand workmen and two hundred million dollars capital.

Mr. Westinghouse was in every sense a thoroughly practical man. He knew how to manage men and how to handle tools with his own hands. In going through his great shops with him I have many times seen him stop and show the workmen that what they were doing was wrong, and then he would take hold and show them the right way. Workmen always respect such an employer.

He cared little for music, art or amusements. His favorite recreation was the working out of some new mechanical problem. Many a night after spending the evening with his guests I have known him to work until the small hours of the morning with pencil and paper over some new idea that had come to him.

He was given many honors both at home and abroad—among the principal ones are the Legion of Honor of France, The Royal Crown of Italy and the Leopold of Belgium. He has been awarded the John Fritz medal and the Edison medal, and just lately the Grashof medal from Germany. He was honorary member and past president of the American Society of Mechanical Engineers, and honorary member of the American Association for the Advancement of Scienc.

He was one of the most lovable of men, always the same, a perfect gentleman. He was the soul of honor. His private life was pure. His honesty and integrity were unquestioned. During an intimate acquaintance of 47 years I never heard from any one any statement that reflected in any way upon his honesty or his upright character. I think without question he will go down through history as a peer for high character among business men of his time. His home life was ideal. His good wife was never forgotten either when he was at home or when absent, and every evening at a pre-arranged time, unless the ocean separated them, the telephone was always brought into use for their evening greetings. He was preeminently a true and devoted husband to his dear wife and a loving father to his idolized son. His family and all of his friends will feel their loss in his death more and more as the years go by and they will realize that never in this life will they find his equal.

S. T. Wellman

Cleveland, Ohio,
April 6, 1914

BIOLOGICAL STATION WORK AT THE UNIVERSITY OF WISCONSIN

The University of Wisconsin will open its biological station to investigators from June 15 to October 1, 1914. During the regular university summer session, courses will be offered in general zoology, general botany, heredity and eugenics, evolution, field zoology, teaching of zoology, dendrology, morphology of algæ,

mosses and ferns, morphology of algæ, seed plants, plant physiology.

Professor M. F. Guyer will have charge of the zoological laboratories, Professor A. S. Pearse will give the field work. Mr. Nathan Fasten and Mr. A. R. Cahn will assist in the general zoological and field courses. Professor H. R. Denniston will direct the botanical work, and the other instructors in this department will be Professor E. M. Gilbert, A. Stewart, W. N. Steil, E. T. Bartholomew, H. E. Pulling and J. P. Bennett.

The city of Madison is admirably located for a biological station. It is surrounded by three beautiful lakes and the adjacent country affords a variety of swamps, marshes, streams, woodlands and prairies. The station therefore offers excellent opportunities for outdoor biological work with all the advantages that go with the equipment of a large university.

For years surveys and investigations on the lake flora and fauna and their conditions of life have been in progress under the auspices of the Wisconsin Biological and Geological Survey, which has its headquarters in the biological laboratory at the university, and the result of these studies will prove of great value to all who are interested in limnology.

A thirty-foot launch capable of carrying a class of twenty-five has just been purchased and will be in commission throughout the summer. An adequate equipment of row boats, nets, seines and other limnological apparatus is also available.

PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

The fourth annual convention of the Pacific Association will be held at the University of Washington, May 21-23, 1914. The following are the constituents and their secretaries:

Technical Society of the Pacific Coast, Otto von Geldern, 865 Pacific Bldg., San Francisco.

The Cordilleran Section of the Geological Society of America, G. D. Louderback, University of California.

The Seismological Society of America, S. D. Townley, Stanford University.

Pacific Coast Branch of the American Historical Associations, W. A. Morris, University of California.

The Pacific Slope Associations of Economic Entomologists, W. B. Herms, University of California.

Pacific Coast Paleontological Society (special meeting), C. A. Waring, Box 162, Mayfield, Cal.

The Philological Association of the Pacific Coast, G. Chinard, University of California.

The Cooper Ornithological Club (not meeting), T. S. Storer, University of California.

California Academy of Sciences (not meeting), J. W. Hobson, 343 Sansome St., San Francisco.

Biological Society of the Pacific Coast, H. B. Torrey, Reed College, Portland.

California Section of the American Chemical Society, B. S. Drake, 5830 Colby St., Oakland.

Astronomical Society of the Pacific Coast (not meeting), D. S. Richardson, 748 Phelan Bldg., San Francisco.

The Geographical Society of the Pacific (not meeting), J. Partridge, 316 Bush St., San Francisco.

Puget Sound Section of the American Chemical Society, R. W. Clough, 4145 Arcade, Seattle.

San Francisco Society of the Archeological Institute of America (not meeting), O. M. Washburn, University of California.

San Francisco Section of the American Mathematical Society, Thos. Buck, University of California.

The following societies will also meet with the Pacific Association:

Seattle Society of the Archeological Institute of America.

The Oregon Section of the American Chemical Society and the Inter-Mountain Section of the American Chemical Society will join with the Puget Sound and San Francisco Sections.

The LeConte Club will hold its annual meeting and dinner.

Political Scientists will hold a meeting for a program and for the preliminary steps in the organization of a Pacific Coast Branch of the American Political Science Association.

The Northwest Society of Engineers will participate in the meeting of the Technical Society of the Pacific Coast.

The Northwest Association of History, Government and Economic Teachers.

Friday evening will be devoted as usual to the dinners of the constituent societies. Saturday evening will be devoted to the general session of the Pacific Association. At this meeting an address of welcome will be given by

Acting President Henry Landes, of the University of Washington, and three papers of a general scientific interest will be given by three members of the constituent societies.

The railroads have granted the usual convention rates for the convention covering the states of California, Oregon, Washington, Idaho and British Columbia.

The proposal for the transfer of the Pacific Association to the American Association for the Advancement of Science as its "Pacific Division" made at the Berkeley meeting in 1913 resulted in the appointment of committees to consider the plan. During the year the two committees have been at work; the general policies and plans of merging have been agreed upon, and at present a smaller committee is drafting a constitution. It is hoped that the transfer can be made at the Seattle meeting.

SCIENTIFIC NOTES AND NEWS

Dr. W. W. Keen, of Philadelphia, has been elected president of the Fifth International Congress of Surgeons to be held in Paris in 1917.

The Bruce Medal of the Astronomical Society of the Pacific has been awarded to Dr. O. Backlund, of Poulkova.

The septennial award under the Acton Endowment has this year been made by the Royal Institution to Professor C. S. Sherrington, Waynflete professor of physiology in the University of Oxford, for his work on "The Integrative Action of the Nervous System."

After twenty-one years of connection with the Yerkes Observatory, Sherburne Wesley Burnham, professor of practical astronomy, will retire from active service on July 1.

The seventieth birthday, on March 25, of Professor Adolf Engler, the director of the Royal Botanic Garden and Museum at Dahlem, near Berlin, was celebrated in the presence of many eminent German and foreign botanists, by several functions. According to the account in *Nature*, on the day itself, Professor Pax, rector of the University of Breslau, with Professors Diels and Gilg, as its editors, presented to Professor Engler a copy of the *Fest-Band* of Engler's "Botanische Jahrbücher." The volume forms a supplement to the fiftieth volume of this publication, and consists of more than forty illustrated contributions, largely from his pupils. Professor Haberlandt presented Professor Engler, on behalf of hundreds of subscribers, with his life-size marble bust, the work of the sculptor, A. Manthe. On March 26 there was a banquet at which the official world was represented; and on March 27 the monthly meeting of the Deutsche Botanische Gesellschaft was converted into an "Engler" meeting, and Professor von Wettstein gave, by special invitation, a lecture on the phylogenetic evolution of the Angiosperm flower.

Dr. Julius Kollmann, professor of anatomy at Basle, has celebrated his eightieth birthday.

Dr. G. T. Beilby, Professor A. Keith, F.R.S. and Mr. J. Swinburne, F.R.S., have been elected members of the Athenæum Club for eminence in science.

S. Alfred Mitchell, Ph.D., director of the McCormick Observatory at the University of Virginia, has been appointed Ernest Kempton Adams Research Fellow of Columbia University for 1914-15. Professor Mitchell is carrying on work in the measurement of stellar parallaxes by the photographic method.

Passed Assistant Surgeon Marshall Guthrie, U. S. Public Health Service, has been appointed chief quarantine officer for the Panama Canal Zone.

Sir Howard Grubb, F.R.S., has been appointed scientific adviser to the Commissioners of Irish Lights, in succession to the late Sir Robert Ball, who held the position for the past twenty years.

Surgeon Joseph H. White, of the U. S. Public Health Service, now stationed in New Orleans, has been given a leave of absence for one year to take up for the Rockefeller Commission, the work of the eradication of hookworm disease in Central and South America.

The Jacksonian Prize of the Royal College of Surgeons for 1913 was awarded to Mr. J.

Howell Evans, F.R.C.S., for his essay on malformations of the small intestine. The subject for the year 1915 will be "Congenital Dislocations of the Joints."

Professor Norman Wilde, head of the department of philosophy and psychology at the University of Minnesota, has been granted a year's leave of absence. Professor David Swenson will act as chairman of the department during Professor Wilde's absence.

Dr. Leo M. Baekeland has been appointed first lecturer upon the Charles Frederick Chandler foundation of Columbia University. Dr. Baekeland's lecture will be given at the University on May 29 in connection with the celebration of the fiftieth anniversary of the founding of the School of Mines.

Professor Bergson began his Gifford Lectures on "Human Personality" in Edinburgh on April 21.

A lecture on "Kilauea in Action" was given to the Sigma Xi Society of Case School of Applied Science, Cleveland, Ohio, on April 6, by Dr. A. L. Day, director of the Geophysical Laboratory at Washington, D. C.

Professor Francis E. Lloyd, of McGill University, delivered a lecture on the subject "The Artificial Ripening of Fruit," on April 4, before the Royal Canadian Institute of Toronto; and, on April 14, before the Clinical Society of the Western Hospital of Montreal on "Colloids and the Ultramicroscope."

Dr. Shosuke Sato, president of the College of Agriculture of the Northeast Imperial University of Japan, is giving his series of lectures on "Fifty Years of Progress in Japan" at the University of Illinois during the two weeks from April 14 to 24. Dr. Sato, it will be remembered, is the second lecturer from Japan in the exchange of lecturers between the United States and Japan.

On March 27, Mr. N. S. Amstutz, research engineer, Valparaiso, Indiana, lectured to the Civil Engineering Society of Valparaiso University on photo-telegraphy.

At intervals of two weeks during the months of February and March, Dr. W. P. Kelley, of the Hawaii Experiment Station, delivered a series of four lectures on soils and soil fertility before the agricultural students of the College of Hawaii at Honolulu.

A bronze medallion of the late Dr. John S. Musser, the work of Dr. R. Tait McKenzie, was unveiled in the University of Pennsylvania Hospital on April 15. Dr. George E. de Schweinitz made the presentation address.

The students and members of the faculty of New York University and Bellevue Medical College hold a memorial service in honor of Dr. Egbert Le Fevre on April 5. Addresses were made by Drs. George Alexander, Elmer Ellsworth Brown, Abram A. Smith, George D. Stewart, Edward D. Fisher and Professor John A. Mandel. Resolutions were passed in recognition of the high esteem in which Dr. Le Fevre was held.

Plans are being made to erect in Lincoln Park, Chicago, a monument in memory of Dr. Nicholas Senn, the distinguished physician.

A portrait of James Gates Percival, Yale, '15, the poet and geologist, has been presented to Yale University by Harvard University.

Alfred Noble, chief engineer of the Pennsylvania Tunnel and Terminal Railroad Company and a former President of the American Society of Civil Engineers, has died at the age of seventy years.

Dr. S. M. Jörgensen, director of the Carlsbad laboratory for chemistry and plant physiology has died in Copenhagen, at the age of seventy-six years.

Dr. Jacques Huber, director of the Musen Goeldi, Pará, Brazil, died on February 18, in his fifty-sixth year.

The death is announced, at the age of eighty-one years, of Mr. G. Sharman, for more than forty years paleontologist to the Geological Survey of Great Britain.

The Honorable Francis Albert Rollo Russell, known for his contributions to meteorology, died on March 30, aged sixty-five years.

Nature says: "By the death of Mrs. Huxley on March 5, in her eighty-ninth year, an-

other link with the scientific society of the latter half of the nineteenth century has been snapped. All who had the happiness of knowing Huxley intimately are aware of the reliance which he at all times reposed on the advice and judgment of his lifelong helpmate. Not only in all domestic concerns, but in questions of literary criticism and even of scientific procedure, he never took a step without consulting her, and her wide knowledge and keen literary instincts made her aid invaluable to him." Mrs. Huxley wrote poems and stories, and prepared a selection from Huxley's writings, "Aphorisms and Reflections from the Writings of T. H. Huxley."

THE U. S. Civil Service Commission announces an examination for associate physicist, qualified in engineering, to fill a vacancy in the Bureau of Standards at Pittsburgh, Pa., at a salary ranging from $2,200 to $2,700 a year, and a vacancy in the Bureau of Standards, at Washington, D. C., at a salary ranging from $2,200 to $3,000 a year.

THE money subscribed in connection with the jubilee celebration of Dr. A. Auwers has been handed over to the Berlin Academy for the foundation of a Bradley Prize, to be awarded once every five years.

WE learn from *The Scottish Geographical Magazine* that the first number of the *Zeitschrift für Vulkanologie*, edited by Herr Immanuel Friedlaender of Naples, and devoted to problems connected with volcanoes or volcanic action, and to appear at irregular intervals, has been issued. In his preface Mr. Friedlaender explains that he has been endeavoring for some years to found an international volcanic institute at Naples, but has met with many difficulties, financial and other. He has therefore established a private institute on a modest scale, and in connection with it is issuing the new journal, which is to contain both original contributions and summaries and abstracts, etc. The first number contains several original papers, the four languages of English, German, Italian and French being all represented. There are a number of fine illustrations, both of Vesuvius and of other volcanoes.

THE interest that has recently been manifested in radium has created a public demand for information both practical and theoretical in regard to the mineral deposits from which it is derived. A short report by Edson S. Bastin on the "Geology of the Pitchblende Ores of Colorado," recently issued by the U. S. Geological Survey, deals mainly with the geology, mineralogy and origin of these deposits, their practical utilization having been treated somewhat fully in other publications. The quantity of uranium ores mined in the United States is exceedingly small, and the great bulk of it, from Utah and southwestern Colorado, does not carry pitchblende but contains the brilliant yellow uranium mineral carnotite. The small pitchblende production of this country is all from the one locality described in this report, in the heart of Gilpin County. It occurs as a constituent of mineral veins which were first worked for their gold and silver content and which still yield important amounts of these precious metals. It is notable that the only other localities in the world where pitchblende has been found in important quantities in mineral veins are the Erzgebirge (in Bohemia and Saxony) and the Cornwall district (in England). Its mode of occurrence in these countries is also described by Mr. Bastin.

ARRANGEMENTS have been made between the New York State College of Forestry at Syracuse University and the Palisades Inter-state Park Commission whereby the college will prepare and carry out a plan of management for the 14,000 acres of forest land controlled by the commission and lying along the Hudson River. The work of getting the forest land into shape will be started about the middle of August by four advanced students under the direction of Professor Frank F. Moon, of the College of Forestry, who was forester for the former Highlands of the Hudson Forest Reservation. The various properties will be mapped out and cruised to ascertain the amount of timber now standing and the amount to be removed. In addition, the fire problem will be studied and eventually a long term reforesta-

tion plan put into force. Centers of insect and fungus damage will be located and timber will be marked so that during the coming winter the park employees will be busy removing the dead, diseased and undesirable specimens. A forest nursery will be developed and active reforestation begun in 1914.

That balsam fir, a tree which a few years ago was considered of little value, is now in demand for pulp wood, is the statement made by the Department of Agriculture in a bulletin just issued on the subject. This demand has been brought about, says the department, by the enormous expansion of the pulp industry during the past two decades, with its present consumption of three and a quarter million cords of coniferous wood and the consequent rise in the price of spruce, the wood most in demand for paper-making. In addition, the department goes on to say, balsam has begun to take the place of spruce for rough lumber, laths and the like, as the price of the latter wood has risen. The chief objection to the use of large amounts of balsam fir in the ground-pulp process of paper-making is said to be due to the so-called pitch in the wood, which injures the felts and cylinder faces upon which the pulp is rolled out. Balsam fir does not have a resinous wood, and the material which gums up the cylinder probably comes from grinding balsam under conditions adapted to spruce wood. Yet from ten to twenty-five per cent., and possibly more of balsam can be used in ground pulp without lowering the grade of the paper produced. It is known that with balsam logs left lying in water over a season this drawback practically disappears. In chemical pulp, produced through the action of acids, these acids are known to dissolve the pitch, and any amount of balsam can be used, though some claim that too much balsam in the pulp gives a paper that lacks strength, snap and character. At the present time, balsam fir furnishes about six or seven per cent. of the domestic coniferous wood used by the country's pulp industry. The tree itself constitutes, numerically, about twenty per cent. of the coniferous forest in northern New York and Maine, and is abundant in many parts of New Hampshire, Vermont, and in the swamps of northern Michigan, northern Wisconsin and Minnesota. It readily reforests cut-over areas, and attains a size suitable for pulp wood in a short time. Under present methods of cutting, balsam fir is said to be increasing in our second-growth forests at the expense of red spruce, and with the gradual decline in the supply of the latter wood the fir will become more and more important commercially.

UNIVERSITY AND EDUCATIONAL NEWS

The faculty of the graduate school of Cornell University has voted to recommend to the board of trustees that Dr. J. E. Creighton, professor of logic and metaphysics, be elected dean to succeed Dr. Ernest Merritt whose resignation takes effect in June. The recommendation by the faculty is virtually equivalent to election. Two years ago President Schurman, in a report to the trustees, proposed that the faculties of the graduate school and the college of arts and sciences be permitted to choose their own deans and the trustees approved the suggestion. Last year the faculty of the college of arts and sciences did select a dean, in the person of Dr. E. L. Nichols, professor of physics.

Dr. George L. Streeter, professor of anatomy in the medical department of the University of Michigan, has been appointed professor of embryology in the Carnegie Institute of Embryology, of the Johns Hopkins Medical school.

Professor Charles McMillan, professor of civil engineering at Princeton University since 1875, has retired and been appointed professor emeritus.

David Camp Rogers, Ph.D., associate professor of psychology at the University of Kansas, has been appointed professor of psychology at Smith College.

Mr. Wilfred Jevons has been appointed junior lecturer and demonstrator in physics, and Mr. A. E. Barnes lecturer in materia medica, pharmacology and therapeutics at Sheffield University.

DISCUSSION AND CORRESPONDENCE

PRIORITY OVERWORKED

HAVING personally been a consistent advocate and practiser of the generally accepted rules of priority, for about fifty years.[1] I have no desire to criticize those who have, in recent years, taken up the subject reasonably and temperately, but it is possible in this, as in most other things, to overdo the matter. My objections to some of the recent rulings and applications of the rigid priority rule are threefold:

First: I believe that the rejection of obviously obscene names should be enforced regardless of priority. This has been done by many excellent writers.

Second: Names that have been pirated or stolen from one author by another should be rejected, if the dishonesty can be clearly shown. The cases of this kind are fortunately not numerous, but some are surprising. Such names should not be allowed to pass current any more than counterfeit money or forged checks.

Third: Names of species so badly describ l that they can not be identified with reasonable certainty should be rejected, especially if no type is preserved. The writings of Linné and other early writers contain many such species. The arbitrary decision of any committee does not alter the case, unless new evidence be given.

To illustrate the second proposition, I will cite a case within my personal knowledge, only omitting names and dates, for obvious reasons, although the incident is not very recent and the parties personally interested are mostly dead.

In this case two eminent and able naturalists and experts, equally interested in the same subjects, attend the meeting of a learned society. Mr. A. reads a paper announcing the discovery of a remarkable new genus and species, say of vertebrates, giving it a MS. generic and specific name. In the description entirely new anatomical terms had to be defined. Mr. B. listens and takes notes. Within a few days B. publishes, in a scientific journal, the discovery of the identical genus and species as his own, and gives it a new name, with no reference to A. His description precedes that of A. by, say, two weeks. The former description is practically the same as the latter, only abbreviated, and even the same newly coined anatomical terms are used, thus proving that the description was a stolen one. Moreover, it afterwards develops that B. had never even seen a specimen of the creature thus described.

Under such circumstances, would the International Committee decide that the pirated descriptions and false names should be adopted in place of those of the real author?

It would be a delicate matter, perhaps, for colleagues to place before the committee requisite evidence in such a case, if recent; but if it were done, what would be the decision? Evidently under the rigid rules of priority, the names given by B. would be upheld, and later on A. would be wrongly accused of copying from B. and changing his names!

Such things have happened more than once, as many zoologists know. Again, suppose that Professor X. is monographing a large collection, say of insects, in his laboratory, to which his assistants and students have access, as is usually the case, and that one of the young men, Mr. Y., looks over his notes, lists or preliminary labels, and then publishes, without permission, the new names of genera and species in some unimportant local list of his own, without descriptions or figures, merely saying that "Professor X., in his forthcoming work, is going to describe such and such genera, with this and that species as types"; and suppose, further, that when Professor X. does publish his work he does not recognize the previous work, and uses entirely different types for the same generic names. Whose

[1] As an evidence of my earlier sentiments, I would call attention to the fact that in 1869 (*Am. Jour. Science*, Vol. XLVII., pp. 92–112), I reprinted the 1845 British Association "Rules of Zoological Nomenclature," with personal notes and suggestions, as footnotes, nearly all of which have been subsequently approved. See also same *Journal*, Vol. III., 1872, p. 387.

names, in such a case, should be adopted? Mr. Y. has pirated the names, but they are in print and have priority. My opinion is that they should be rejected as stolen goods.

This is not an imaginary instance, and such cases have happened more than once. Mr. Y., in such a case, may be thoughtless, rather than criminal, but the resulting confusion in nomenclature is the same.

It seems to me that the case of Fr. Weber, 1795, *versus* Fabricius, 1798, concerning the genera of Crustacea, is a case of just about this sort, yet the committee has decided in favor of the obscure and rare pamphlet of Weber, as against the important work of Fabricius, from whom the generic names were apparently stolen, or improperly borrowed, for Fabricius did not adopt or recognize many of the genera in the forms prematurely published. To adopt the pirated generic names is to throw crustacean nomenclature into much confusion.

If the unauthorized publishing of scientific names is to be upheld as valid, then a reporter for any newspaper or magazine who chooses to report technical papers and note down the names used in a meeting of a learned society may have to be quoted as the author of the names, whether rightly or wrongly spelled. I could give cases of this kind, but it is best to forget them, no doubt, for somebody might revive them, as valid publications.

To illustrate the first and third propositions we may take up an article by Professor J. Playfair McMurrich, "The Actinaria of Passamaquoddy Bay, with a Discussion of Their Synonomy." [2]

In this article the author tries to restore certain names given by Linné to some obscure Norwegian species, in place of those almost universally adopted by European and American writers for some of the best known species common to both coasts.

He brings forward no evidence that has not been well known to nearly all writers on the subject. He himself admits that the descriptions given by Linné are insufficient to identify any species, and he therefore depends on the references made by Linné later (in edition XII.) to various earlier writers, as was his habit in many groups. Every one familiar with his work must recognize that he often made such references very loosely, mainly to give some general idea of the looks of a thing, without intending to imply absolute identity. McMurrich picks out certain figures, among several referred to by Linné, that he thinks can perhaps represent the species intended, but he rejects various others, and thus guesses at what Linné had in mind, even when the figures disagree with the descriptions.

In fact, Linné was profoundly ignorant in respect to most marine Invertebrates, except shells. His descriptions of Actinians are no better than an intelligent boy twelve years old could write, after five minutes of watching these creatures, and his references to figures are as careless as his descriptions. Therefore his actinian species should be dropped as indeterminable, even if there were no other good reasons. The leading European authorities, familiar with the actinians of the same region, have never been able to agree as to his species, and they surely ought to have an advantage over an American in such matters.

But this is not the only reason why most writers, before McMurrich, have wisely rejected the names. The most convincing reason has been their obscenity. No writer has been more familiar with north European actinians than P. H. Gosse. In his "Actinologia Brit.," 1860, he quotes both *A. senilis* and *A. judaica* of Linné under *A. dianthus;* and also *A. senilis* and *A. felinia* under *Tealia crassicornis*. But he dismisses these names as entirely "out of the question," on account of their objectionable significance.

Linné gave obscene names to some genera and to many species. These, in many cases, were merely the dirty names given to many marine creatures by the local fishermen and put into a Latin form by Linné or his predecessors. Such obscene names (often the same) are still in use, even by American fishermen, as I know from long experience.

[2] *Trans. Royal Soc. Canada*, Vol. IV., 1911, p. 59.

Once, when I asked the captain of a Cape Ann fishing schooner what names they gave to certain actinians, holothurians, ascidians, etc., he said, "We should not dare to tell our wives and daughters," and I agreed with him. Such are the names that McMurrich and some others would like to revive!

It is rather embarrassing, when asked by an educated lady the name of a beautiful sea-anemone, to have to say that its name is "*Priapus senilis*," or even *Metridium senilis*; or "*Priapus humanus*" Linné, for another creature; or to give other equally unjustifiable names.

That Linné used these and other names in an obscene sense is evident, not only because often derived from fishermen's dirty names, but because he described his species in the terms of human anatomy of sexual organs, in many cases, too absurd to mention.

It is, therefore, unfortunate that a zoologist of such excellent ability as Professor McMurrich, should waste his time trying to revive these old, dirty, indeterminable names, which he himself admits can not be definitely applied to any species by means of the descriptions themselves, while his indirect evidence is equally uncertain. The names that he thus adopts are *Metridium senilis* for *M. dianthus*; *Urticina felina* for *U. crassicornis*; *Priapus equinus* for *Actinia mesembryanthemum*.

In the tenth edition of the "Syst. Nat.," 1758, p. 656, the two species of "*Priapus*" are *P. equinus* and *P. humanus*. The latter is a sipunculoid worm. I do not know that any one has recently tried to revive this name. It has better claims than some of the others.

For *P. equinus* the only description (1758) is "semiovalis læviusculus." Surely not very edifying! In Fauna Suecica, p. 510, he has three more species: *P. senilis*; *P. judaicus*; *P. felinus*. The first has, as a diagnosis, only this: "subcylindricus rugosus," with a three-line descriptive note, to the effect that it is the size of the last joint of a finger; that it is fuscous, sordid, rough, with a subcoriaceus tunic, with the upper part soft, thin and sanguineous. These characters surely do not apply to *M. dianthus*, which is large, soft and smooth throughout, and especially delicate and translucent, when as small as the one mentioned by Linné. It does not have the upper part sanguineous, however much it may vary in color. There are other species on the Norwegian coast that agree with the brief description far better. This identification by McMurrich is then in itself untenable, as well as undesirable.

As for "*Priapus felinus*," 1761, the case is no better. The diagnosis is "cylindricus lævis glande muricata." The descriptive note is "simillarius priori," "sed glande muricata." No reference to earlier works. What he means by a "muricate glans" is hard to understand, if he had a soft actinian before him, like *Actinia mesembryanthemum*. Perhaps he refers here to another sipunculoid worm.

As for the generic name *Priapus*, 1758, if it is to be used at all, it must be applied to the second species, *humanus*, as the type, for the first species was very early (1767) placed in *Actinia*. Whether helminthologists will adopt the name remains to be seen.

A. E. VERRILL

THE EDUCATIONAL VALUE OF MATHEMATICS

TO THE EDITOR OF SCIENCE: In a speech before the Cincinnati Schoolmaster's Club on February 21, 1914, Professor E. L. Thorndike, of Columbia University, made certain statements with regard to the educational value of mathematics and the classical languages, which were quoted in the issue of the *Cincinnati Enquirer* for February 22. One of the statements as quoted was that

> the old notion that Latin or mathematics made the mind more effective in all the work of business, law or other professions was largely superstition.

The phraseology of this statement is certainly misleading. By the use of the expression "old notion" Professor Thorndike tends to convey the impression that no up-to-date, intelligent person has such a notion. That this is the very reverse of the truth may be seen by quoting from an article by Professor C. J. Keyser in the issue of SCIENCE for

December 5, 1913, entitled "The Human Worth of Rigorous Thinking." Professor Keyser is the head of the department of mathematics at Columbia University, Professor Thorndike's own institution, and is a writer of international repute on mathematical subjects and particularly on the educational value of mathematics. I leave it to any one to judge as to who is better qualified to speak with authority on the subject of mathematics and the pedagogy of mathematics, Professor Thorndike or Professor Keyser.

Professor Keyser says in the course of his paper:

> We are beginning to see that to challenge the human worth of mathematics, to challenge the worth of rigorous thinking, is to challenge the worth of all thinking, for now we see that mathematics is but the ideal to which all thinking, by an inevitable process and law of the human spirit, constantly aspires. We see that to challenge the worth of that ideal is to arraign before the bar of values what seems the deepest process and inmost law of the universe of thought. Indeed we see that in defending mathematics we are really defending a cause yet more momentous, the whole cause, namely, of the conceptual procedure of science and the conceptual procedure and activity of the human mind, for mathematics is nothing but such conceptual procedure and activity come to its maturity, purity and perfection.

If Professor Thorndike had read Professor Keyser's paper, of which I have only quoted a brief extract, I doubt if he would have characterized as "superstition" ideas which are so vigorously maintained by one of the men best qualified to speak with authority on the subject in question.

Another statement by Professor Thorndike is that

> Mathematics improves mathematical reasoning but not the power to reason in general.

I am yet to be convinced that there is more than one kind of reasoning; whether one reasons in mathematics or in some other subject, he is going through the same process. Mathematics furnishes the best training in reasoning because the student is required to reason more frequently than in any other subject, and because he is always in a position to test the validity of his reasoning by means of exact concepts.

However, I am not writing this letter because the opinion of some of the educational faddists of the day with regard to the educational value of mathematics is a matter of much significance to a mathematician, in itself. I *am* writing it in defense of a rational curriculum in the high schools and the elementary schools. Having received my own preliminary education in the Cincinnati schools, and having had considerable opportunity of late to observe the preparation of students entering college from this community as compared with that preparation some fifteen years ago, I can only deplore the modern tendency to give at most a superficial attention to fundamental subjects, and to divide the student's energy and attention among a multitude of subjects in such a manner as to create in his mind hopeless confusion and to prevent his having really definite ideas about anything in particular.

The teachers in the high schools and the elementary schools are working just as hard as ever, are just as efficient as ever, but they can not obtain as good results under the handicap of present-day curricula. The student can not be trained to think in as effective a manner as he was fifteen or twenty years ago, under present circumstances. And I believe any reasonable person will agree that the primary object of education is to teach the student to think, whether he is going to enter college or is going out into the world at the end of his high-school course.

But those who have been most responsible for this unfortunate state of affairs in the high schools and the elementary schools, far from realizing the work of destruction that they have already done, are now endeavoring to complete it by attacking what is left of valuable educational training in the curricula of to-day. It is high time that those who see the danger of this movement, and I know there are many, make a resolute stand against it. If such statements as those of Professor Thorndike are allowed to go unchallenged, and thus

to appear to the general public as having the weight of authority behind them, there is no telling where we shall be before the inevitable reaction sets in.

Personally I believe that every student who takes a four year course in high school should be required to study the English language during those four years, and at the same time he should be getting some definite knowledge of either mathematics or the classical languages, preferably of both. Distinct vocational training might well be left in the background until the student has had an opportunity to get some real mental training. I know this is the opinion of the great majority of my colleagues at the University of Cincinnati, including Dean Schneider, of the college of engineering, who is a recognized expert on vocational training. And I do not doubt that it is the opinion of the great majority of college teachers throughout the country.

CHARLES N. MOORE
UNIVERSITY OF CINCINNATI

SEX IN MULTIPLE BIRTHS

IN a copy of lectures delivered by Dr. Raymond Pearl at the 1912 Graduate School of Agriculture at Lansing, Mich., I find the following tables given, indicating that in multiple mammalian births as the numbers per birth increase, the ratio of males to females decreases.

Man

No. Young per Birth	Males per 1,000 Females
1	1,057
2	1,043
3	548

Sheep

3 Males	2 Males; 1 Female	2 Females 1 Male	3 Females
16	39	22	38

In the sheep there are 215 females to 180 males.

It is worthy of note that these data are from normally uniparous species. In swine where the number at a birth may vary from one to twenty-three (in an exceptional instance) this excess of females is not apparent. In 174 litters the number of males per litter and the expectation based on chance, using the relative frequency of the different-sized litters (fourteen per litter being the largest) was as follows:

No. Males per litter	0	1	2	3	4	5
Expectation	3.4	12.8	24.6	33.4	34.7	28.5
Actual	2	13	26	28	31	28

No. Males per litter	6	7	8	9	10	11
Expectation	19.0	10.4	4.6	1.7	0.48	0.11
Actual	21	12	8	2	2	1

This shows but a slight departure from expectation and is within the limits of error for such small numbers. It seems doubtful if there is a tendency toward increased proportions of females in multiparous births. In fact the excess is slightly on the male side here.

In 126 births from various private collie, fox terrier, Scottish terrier and Boston bull terrier records, the following results appear:

No. male pups	0	1	2	3	4	5	6
Expectation	15.1	35.75	37	24.5	10.86	2.8	.3
Actual	14	36	39	22	11	4	0

These statistics give qualitatively the same result. That this accordance with expectation on the basis of chance is not necessarily a property of normal multiple births, is shown by the following statistics on sheep triplets from the Iowa State College flock and two farmers' flocks located near there. The total number of lambings is 146.

	3 Males	2 Males; 1 Female	1 Male; 2 Females	3 Females
Expectation	18.25	54.75	54.75	18.25
Actual	21.00	56.00	51.00	18.00

This gives 226 males and 212 females. The smallness of these numbers does not conclusively indicate that influences other than mere chance do not operate, but they are interesting since they give opposing evidence on the point discussed by Dr. Pearl.

EDWARD N. WENTWORTH
CHICAGO VETERINARY COLLEGE,
July 26, 1913

SCIENTIFIC BOOKS

Biochemie der Pflanzen. Von DR. FRIEDRICH CZAPEK, Professor der Anatomie und Physiologie der Pflanzen an der K. K. Deutschen Universitaet in Prag. Zweite, umgearbeitete Auflage. Erster Band, pp. xix., 828, mit 8 Abbildungen im Text. Verlag von Gustav Fischer, Jena, 1913. M. 24.00, geb. M. 25.20.

In reviewing a recent foreign treatise on organic chemistry, one of our best chemists, who is also very favorably known as an investigator, made the remark that it was so much more difficult to teach organic chemistry to-day than it was a generation ago, apparently for the reason that the field to be covered is so much greater now than it was then. Recently a graduate student, who was attending a course of lectures on organic chemistry by way of review, made the statement that in the course of his college career he had heard a number of organic chemists lecture and that while their method of presenting the subject differed in each case, the lecturer had invariably introduced his topic by stating that he did not expect his students to learn something about each of the hundred thousand and some odd tens of thousands of organic compounds catalogued in Beilstein and its supplements. It would seem that some of the horror which so many students experience, or at least feign to experience, at the number of organic compounds when they first approach the subject, is due in part at least to their teachers. While we profess that we are not frightened by the numbers of carbon compounds and inform our students at the outset that they need not be horror-stricken by any such mass action, yet we seem to feel, and even proclaim that, because of the enormous strides made by organic chemistry, we need more time than formerly to cover the ground though but in an elementary fashion. If, *e. g.*, we measure the growth of organic chemistry by the ten thousand or more carbon compounds that have been added to our catalogue in a given period, then indeed our point of view must make us pessimistic as to the ultimate outcome of our success as teachers of the elementary part of our subject in any rational allotment of time at our disposal during the college quadrennium.

Any organic chemist who has reached middle age may well appreciate the mental state of chemists of the old school who found themselves confronted by Kekulé's structural theory. But, if they were confounded it was due, not so much to the rapid growth in the number of compounds that resulted from the application of Kekulé's views, as from the different mental attitude that the structural theory demanded. The Grignard reaction, though in short space it has produced thousands of new compounds at a time when the progress in organic chemistry was referred to as having become sluggish, wrought no visible disturbance whatever for the simple reason that it brought no new fundamental theories into play, hence made no demands on our mental attitude toward the subject. Any one who has studied the life of Liebig carefully must have noticed that underneath the surface there was something more than dissatisfaction toward the university administration that caused him to leave Giessen. The theory of substitution was revolutionizing organic chemistry in spite of Liebig's attitude and in spite of the "S. C. H. Windler" which Woehler hurled at the French chemists. But whereas Woehler adapted himself as well as he could and stuck to his post and his "Fach," Liebig found it more convenient not only to migrate, geographically speaking, but to "umsteigen"—if this apt expression by Mark Twain may be permitted in so serious a topic as this—or to "umsatteln" if a German phrase when applied to the change of a German chemist from the pure to the applied seem preferable.

The structural development of organic chemistry has made it possible to treat the subject-matter deductively rather than inductively. The claim of inductive treatment in science has become a sort of fetish. We have preached this doctrine to such an extent to our students that we dare not admit that

our method of procedure after the first or second lecture is largely deductive. If in organic chemistry we have the courage to be outspokenly deductive from the start and insist on its logical consequences, half of the battle is won. To be sure there are still a sufficient number of difficulties to be overcome, but they do not consist in numbers, but rather in the possibility of acquiring the right mental attitude.

To a large extent plant chemistry is organic chemistry. However, whereas most of the new organic compounds that are produced synthetically find a convenient place in the well-regulated drawing room of organic chemistry, most of the new substances isolated from the vegetable kingdom—and many of the old timers from the same source—still belong to the lumber chamber of organic chemistry.

It is true that organic chemistry consists of something more than the study of the physical and chemical properties of chemical individuals containing all the way from one to a host of carbon atoms. Modern organic chemists with adequate physico-chemical training appear but too anxious to rub this fact into their older colleagues. This is equally true of the organic chemistry of the vegetable kingdom, but to a much greater degree. The "Grundlagen und Ergebnisse der Pflanzenchemie" by Euler, one part of which consists of a briefly descriptive catalogue of the *materia phytochemica* and two parts of which are a text on physical chemistry with occasional phytochemical application, are but a partial expression of the truth of the above assertion. Great as has been the dovelopment of physical chemistry, more particularly since Ostwald "made school" at Leipzig, it has scarcely begun to explain the problems of the "Biochemistry of the Plants," though it has touched upon this subject at innumerable points. Whereas the application of structural chemistry to the *materia phytochemica* has made possible a large amount of systematization and has thus simplified the situation, physical chemistry has thrown but dim light on innumerable spots. The status of the application of physical chemistry to biochemical problems is approximately that of the status reached in organic chemistry when Berzelius characterized the discovery of the benzoyl radicle by Liebig and Woehler as the dawn of organic chemistry. Daylight is beginning to dawn in the study of biochemical problems, but before daylight appears much more generalization will have to be made possible, not only by the extension of present physico-chemical methods over a large field, but by a much better understanding in each and every department of biochemical research. The single chapter of catalysis, always a convenient word to cover our ignorance, and its application to enzyme action is sufficient illustration.

To attempt to write a comprehensive biochemistry of plants under present conditions is a stupendous undertaking. The mere cataloguing of the constituents of plants as attempted by Wehmer in his "Pflanzenstoffe" for the Phanerogams has proved sufficiently burdensome to discourage even the most ardent compiler. Hence one is not surprised to learn that Czapek has gladly availed himself of the opportunity to unload a part of this work, as undertaken in the first edition, by referring his readers to Wehmer for more complete data so far as the constituents of phanerogams are concerned. Yet in spite of this limitation, the first volume has grown enormously. If it is more of a true biochemistry than was the corresponding volume of the first edition, this is due not so much to this sort of unburdening as it is due to the greater attention and more space given to general considerations. Readers of this review who have been accustomed to resort freely to the first edition for information may be interested to compare the figures given in the following outline of the contents of the second edition with the corresponding figures of the first. At the same time the following data will give a better idea of the contents to those not already acquainted with Czapek.

Preceded by a short historical introduction of nineteen pages, the contents of the volume are classified under two general heads, viz.,

General Biochemistry (pp. 20 to 240) and Special Biochemistry (pp. 240 to 820). The first part is subdivided into four chapters:

1. The substratum of the chemical changes in the living orgsnism, the protoplasm (pp. 20 to 65).

2. The chemical reaction in the living plant organism (pp. 66 to 146) including such topics as the conditions of the reactions, the time element, catalysis, enzymes, immunity.

3. Chemical stimulation (pp. 147 to 233) including growth in all of its aspects.

4. Phenomena of chemical adaptation and inheritance (pp. 234 to 239).

The subject-matter under special biochemistry is arranged into parts, divisions and chapters. Part I. deals with Saccharides and the rôle which they play in plant metabolism (pp. 240 to 708). The "general division" discusses the vegetable sugars. The "special division" takes up the following subjects in as many chapters:

5. The sugars and carbohydrates in fungi and bacteria.

6. The resorption of sugars and carbohydrates by fungi and bacteria.

7. The carbon assimilation and sugar formation by fungi and bacteria.

8. The carbohydrate metabolism in the Algæ.

9. The reserve carbohydrates of the seeds.

10. The resorption of sugar and carbohydrates in the germinating seeds.

11. The formation of reserve carbohydrates in the seed.

12. The carbohydrate metabolism in underground reserve organs.

13. The carbohydrate metabolism in shoots and leaf buds.

14. The carbohydrate metabolism in foliage leaves.

15. The carbohydrate metabolism in the reproductive system.

16. The carbohydrate metabolism in phanerogamic parasites and saprophytes.

17. Resorption of carbon compounds by means of the roots and leaves of phanerogams.

18. Secretion of sugar and carbohydrates.

The phytochemical synthesis of sugar in the chlorophyll receives an exhaustive treatment (pp. 506 to 628). The subject of saccharides as skeleton substances of the plant body is similarly treated.

Part II., the last part of the first volume, is devoted to the lipoids in plant metabolism, which subject is treated under two principal heads: the nutritive lipoids and the cytolipoids. Under the former head we find,

22. The reserve fats of the seeds.

23. The resorption of fats during the germination of the seed.

24. The formation of fats in ripening seeds and fruits.

25. Reserve fats in stems, etc., and foliage leaves.

26. Fat as reserve material in thallophytes, mosses, ferns and pollen grains.

Under the head of cytolipoids the following subjects are discussed:

27. Vegetable lecithines (phospholipoids).

28. Vegetable cerebrosides.

29. Sterinolipoids of plants.

30. Vegetable chromolipoids.

31. The production of wax (cerolipoids) in plants.

Thus it becomes apparent that volume one, although it has greatly increased in size, considers but two groups of phytochemical substances and the biological problems which they suggest. If the chemistry of the simple saccharides has been in a fairly satisfactory condition since Fischer paved the way to a better understanding, we must not forget that we have but entered the vestibule of a carbohydrate chemistry and that the problem of the photosynthesis of the simplest sugar has not yet been solved to the complete satisfaction of the physiologist.

It has evidently been the endeavor of Czapek to bring together the available information on a given subject and to classify the information as indicated by the chapter headings quoted above. This manner of treatment does not make a good text-book, but with the extensive references to original literature

it makes an admirable reference book. Czapek has also refused to assume the rôle of arbiter, but quotes, with as little prejudice as can be expected, the opinions of each individual, leaving it to the reader to arrive at his own conclusion.

In closing, a single allusion to the greater importance that is being accorded to phytochemistry in recent years may not be out of place. For more than a generation after the announcement of the benzene theory by Kekulé, organic chemists could think of little else than synthesized substances and of coal tar as their gold mine. So one-sided were they at times that they did not even see the element of the ridiculous in the suggestion to make foodstuffs artificially from this source. The other extreme has now been reached by the pure-food chemist who by big head lines in the newspapers and the waving of red rags before large audiences denounces this same coal tar as the source of everything that is bad. A much more common sense reaction has been started by those chemists who have been pointing out how the intricate process of the plant laboratory may be husbanded for the benefit of mankind by farmers who need not be Ph.D.'s but who have been taught by the biochemist to make the most of their opportunities.

Again, while we should welcome the new synthetic remedies that have been turned out by the "Farbenfabriken" of the fatherland, we should not forget that in this field also the plant still produces valuable remedies which we can obtain as well or better from living or recently dead plants than as a by-product from fossilized plants of former geological ages.

But aside from the agricultural and pharmaceutical or medical aspects which the chemical study of plants and plant life may afford, the study of these subjects for its own sake has a charm all its own. Who can view the beautiful color of the flowers or inhale their perfume without feeling that a knowledge of the processes by which the plant produces these physiological effects on the intelligent animal is in itself worth knowing though the pigment never be used to dye a fiber, nor the perfume be extracted in order to find a place on my lady's toilet table

EDWARD KREMERS

A History of Land Mammals in the Western Hemisphere. By WILLIAM BERRYMAN SCOTT, Blair Professor of Geology and Paleontology in Princeton University. New York, The Macmillan Company, 1913. Pp. i–xiv + 1–693, with frontispiece and 304 text-figures.

In this striking volume Professor Scott has striven to assemble and set before the lay reader a judicious selection from the great accumulation of facts which the many students of mammalian paleontology have discovered. The presentation of the subject is essentially different from that of Professor Osborn's "Age of Mammals" wherein the rise and spread of faunas are treated as a succession of historical events. In the present work, after certain introductory chapters, the treatment is zoological, the life history of each of a number of important orders being discussed from beginning to end. Thus the two works by two of the foremost American paleontologists are supplemental; collectively they give a complete picture of Tertiary time.

The first two chapters of Professor Scott's book acquaint one with the methods pursued by the student of past life, the one showing the way whereby the geological data are interpreted, and the other the methods of paleontological research—how animals are preserved from the remote past, the nature of the remains, the way in which the characters they show are explained, and the method whereby the animal is reconstructed as a living being. A chapter on the principles of taxonomy is concluded by a full mammalian classification which is almost identical with that given by Professor Osborn in the "Age of Mammals," the only differences being relatively unimportant. The discussion of the skeleton and teeth of mammals, so essential to an understanding of fossil evidence, is followed by a chapter on the principles of geographical distribution of mammals and a summary of the successive mammalian faunas.

The succeeding chapters elucidate the histories of the principal orders: the Perissodac-

tyla—horses, titanotheres, rhinoceroses; the Artiodactyla—swine, camels, deer; the Proboscidea; and of the primitive ungulates, the Amblypoda and Condylarthra. There follow a number of chapters devoted to the peculiar South American ungulates, on which Professor Scott is so pronounced an authority, and these give place to a discussion of the carnivores, primates, edentates and marsupials.

Chapter XVIII. is philosophical, in that it expresses very clearly Doctor Scott's ideas concerning the modes of mammalian evolution. He states in explanation of the variations found between the "family trees" that "It is quite impracticable to construct a genetic series without making certain assumptions as to the manner in which the developmental processes operated and the kinds of modification that actually did occur," and the facts upon which these assumptions are based are ascertained by several distinct methods. Of these the oldest is comparative anatomy, an accurate knowledge of which is indispensable to the use of the others. The second is that of embryology, for, while Haeckel's famous biogenetic law, wherein the life history of the individual is supposed to give a résumé of that of the race, is proved not to be implicitly trustworthy for the interpretation of structural features, nevertheless the information attained through study of the embryonic stages is of the greatest service in the solution of zoological problems.

The third method, experimental zoology, especially that part known as genetics, has also taught us much; but the fourth, paleontology, despite the imperfection of the record due to the irretrievable loss of much of the past history of life, nevertheless has the preeminent advantage of offering to the student the actual stages of development, as it preserves the original documents and in the true order of succession.

In summation, Professor Scott remarks: "It is only too clear that the principles as to the modes of mammalian development which can be deduced from the history of the various groups must, for the most part, be stated in a cautious and tentative manner, so as not to give an undue appearance of certainty to preliminary conclusions, which should be held as subject to revision with the advance of knowledge. Much has, however, been already learned, and there is every reason to hope that experimental zoology and paleontology, by combining their resources, will eventually shed full light upon a subject of such exceptional difficulty" (p. 663). A full glossary completes the volume.

The illustrations are in part from photographs of living mammals and clear anatomical drawings of certain essential skeletal features, but what will interest the general reader most are the admirably drawn reconstructions of extinct forms done by R. Bruce Horsfall under the careful supervision of Professor Scott. There are also others by Charles R. Knight, whose work always has a realism which no other artist of the prehistoric has ever attained.

In the production of this work Professor Scott has done a lasting service to the serious student of paleontology, as well as to the lay reader, and it is to be hoped that the admirably conceived and executed volume will have the appreciation it deserves.

Richard S. Lull

Yale University

The Hill Folk. Report on a Rural Community of Hereditary Defectives. By Florence H. Danielson, M.A., and Charles B. Davenport. Eugenics Record Office. Memoir No. 1.

As explained in the preface, this is the first of a projected series which is intended to embody some of the more extended research of the Record Office. Dr. Davenport calls attention to the fact of its primary value to sociologists rather than to students of inheritance traits—which latter will require much more extended study, which, we are assured, will come later.

This Hill Folk study began with pedigrees of some of the inmates of the Monson State Hospital at Palmer, Mass., and extended to a town of 2,000 inhabitants in a fertile valley on a railroad between prosperous cities. The town is frequented by tourists who about

double the population during the summer. A lime kiln and a stone quarry represent the only industries outside of prosperous farming. that are followed. The Hill Folk descended from two men, a shiftless basket maker, known here as Neil Rasp, and an Englishman, owner of a small farm, both of whom came to the settlement about the year 1800. Their descendants have "sifted through the town and beyond it. Everywhere they have made desolate, alcoholic homes which have furnished state wards for over fifty years, and have required town aid for a longer time."

After an explanation of the charts—which are printed in the circular form with lines of descent radiating from the center and oldest generation—and a general survey of the strains involved and their traits, the following topics indicate the methods of study followed, viz., (*a*) inheritance, (*b*) marriage selection, (*c*) financial burden entailed by criminals and dependents (with a comparison with the Jukes), (*d*) survey of the present school children and (*e*) heredity and environment. An appendix takes up a detailed history of the separate families and certain individuals and their characteristics. The usual conventional symbols (American) are employed, though an apparently successful effort has been made to distinguish two degrees of mental deficiency and to indicate the same by the symbols. The members of the higher group, which are indicated by the letter "F" on white background, are able to support themselves in an inefficient "meager way," but "lack ambition, self control, common sense and the ordinary mental and moral capacity for differentiating between right and wrong." The individuals of the lower group, indicated by the symbol on a black background, are incapable of self support and "are a special menace to the community from their lack of all mental and moral stamina."

The symbol "Sx" is applied to the cases only where the "sex impulse works unhindered" from a lack of proper balance between the impulse and self control, as distinguished from those who only incidentally commit a sexually immoral act.

There is considerable data found in this study for comparing the effects of changes of environment.

An excellent lesson is derived from the study of one typical case showing the result of permitting marriage between and propagation of children by a pair of evident defectives. Of eleven children born from this union, all but two, that died in infancy, became public charges. Seven were known to be feeble-minded. Two of these and one of the infants that died early were epileptic.

An exceedingly interesting and instructive study is the survey of seventy-five school children from these families. Of these, school records were obtained in all but seven cases. From these the mental characteristics are noted. Thirty-eight are below the grade in which they should be in the schools, and in general they are either unable to fix attention upon one thing long enough to grasp it or require so much time to comprehend ideas that they progress very slowly. Usually they are "quiet, stupid laggards." The aggressive disturbers of social peace, though present, are the exceptions here.

This study of eight hundred and thirty-seven people has involved an immense amount of work on the part of the field worker, Miss Danielson, and has been subjected to a very searching and critical analysis by Dr. Davenport. It is full of interesting material for comparisons, some of which are discussed by the authors; as, for instance, the effects of dispersion of the feeble-minded groups; the attempt to approach the determination of unit mental characteristics; the ultimate cost of early segregation as compared with its neglect, etc.

The following is a brief summary of conclusions given.

"1. The analysis of the method of inheritance of feeble-mindedness shows that it can not be considered a unit character. It is evidently a complex of quantitatively and qualitatively varying factors most of which are negative, and are inherited as though due to the absence of unit characters.

"2. The value of out-marriage, exogamy, as a means of attenuating defective strains is

diminished by the action of social barriers and the natural preference of individuals, which induce marriages among like grades of mentality, in a foreign as well as a native locality.

"3. The amount of town aid which this one group of defective families requires decennially has increased 400 per cent. in the last thirty years. In the same length of time its criminal bill has been $10,763.43 for sixteen persons; and the bill for its thirty children who were supported by the state during the last twenty-three years is $45,888.57. During the past sixty years this community has, it is estimated, cost the state and the people half a million dollars.

"4. Half of the present number of school children from these families who are living at home show evidence of mental deficiency.

"5. One half of the state wards from the community in question have reacted favorably in an improved environment and give promise of becoming more or less useful citizens; the other half consist of institutional cases and those which have not reacted to the better environment, but are likely to become troublesome and dangerous citizens.

"6. The comparative cost of segregating one feeble-minded couple and that of maintaining their offspring shows, in the instance at hand, that the latter policy has been three times more expensive."

Valuable as are the deductions from such a piece of work as this, its greatest value lies in the number of facts collected and recorded, which will always be available for later comparisons in two ways, viz., with any subsequent information concerning the same people, and with collected facts concerning other families and settlement groups as they are being secured in different parts of the country.

A. C. Rogers

The Microtomist's Vade-mecum. A Handbook of the Methods of Microscopic Anatomy. By Arthur Bolles Lee. Seventh edition. Philadelphia: P. Blakiston's Son & Co. Pp. x + 526. 1913.

The appearance of a new edition of this well-known handbook will be welcomed by biologists, many of whom, like the reviewer, have doubtless awaited its appearance with some impatient anticipation. Although entitled a "Handbook of the Methods of Microscopic Anatomy," the field covered is broad, as there are included methods employed by embryologist, histologist, zoologist and botanist. The need the book aims to meet is thus not a simple one. The extensiveness of the field calls for a careful selection from a large mass of material, of standard methods of real value which need to be worked over and personally tested. This the author has in most instances done and hence the greater practical value of the book.

The present edition conforms to the previous one in arrangement, form of presentation and size—this last despite the addition of considerable new matter ("more than 700 new entries in the index"). Indeed, of the thirty-six chapters that make up the book the only ones which are increased in length are those on Embryological Methods (Ch. XXV.) and Nervous System; Cytological Methods (Ch. XXXIII.). The condensation has been secured by "cutting out superfluous matter, condensation of the text and typographical compression." The sections relating to neurofibrils and to blood and blood parasites the author states in the preface have been almost entirely rewritten. Of important additions to histological technique introduced since the previous edition, the author specifically mentions Gilson's mounting media, camsal balsam and euparal, which permit mounting direct from 95 per cent. alcohol, and also improvements in the Bielschowsky and Cajal silver methods.

As in the previous editions, the methods considered by the author more important are presented in larger type, those less important in small type. The references to the original articles are in all instances given and are, as far as the reviewer has tested them, exact.

It would not be difficult in a book of this kind whose excellence depends upon a rigorous selection and personal emphasis, for a worker to cite methods which might well have been included or which seem to merit more

emphasis, such as Wright's blood stain and Mallory's connective tissue stain, the latter not given in its latest form. Hasting's Nocht's blood stain is not mentioned, nor the value and usefulness of formalin with the freezing microtome. Under embryological methods the modeling methods should perhaps have been given more attention, and to the von Wijhe methylene blue clearing method for cartilage might well have been added others such as the alizarin oil of wintergreen and benzyl-benzoate method (Spaltcholtz) and the Schultze caustic potash and glycerin clearing methods for bone and nerves. But when all is said, the emphasis should be placed, not on what has been omitted, but on the large number of standard methods that have been included.

The index is full, cross references are numerous and the typography, paper and binding satisfactory; typographical errors are rare; in fact, the high standard of the sixth edition has been maintained in the present one, which, like those that have preceded it, may be expected to occupy an important place on the table of the practical worker with the microscope in the field of biology.

B. F. KINGSBURY

SEVENTH LIST OF GENERIC NAMES (TUNICATES) UNDER CONSIDERATION IN CONNECTION WITH THE OFFICIAL LIST OF ZOOLOGICAL NAMES

26. Notice is hereby given of the receipt by the secretary of the Commission on Nomenclature of the following communication regarding generic names of tunicates. All persons interested in the matter are cordially invited to submit to the secretary any arguments for or against the proposed action. In accordance with instructions from the International Congress, the secretary is required to give at least one year's notice to the zoological profession before the Commission takes any action involving the acceptance of any name under the plenary power for suspension of rules.

27. In accordance with instructions from the Congress, copies of this notice are sent simultaneously, but without comment, to the following journals: *Bull. Soc. Zool. France*, *Monitore Zoologico*, *Nature*, SCIENCE, *Zool. Anz.*

Doliolum, *Pyrosoma*, *Salpa*, *Cyclosalpa*, *Appendicularia* und *Fritillaria* sind gegen Aenderung zu stützen.

Wir 12 unterzeichneten Tunicatenforscher sind übereingekommen, die 6 genannten Genusnamen pelagischer Tunicaten als gültig anzunehmen. Die Namen dieser Tunicaten werden von jedem Zoologen als vollkommen eingebürgert anerkannt werden, ihr Gebrauch hat bisher niemals zu Missverständnissen Anlass gegeben, die Genera sind Paradigmata in der zoologischen Systematik, sie spielen in der Entwicklungsgeschichte eine grosse Rolle und beanspruchen in der Tiergeographie, Planktonforschung und auch in der Hydrogeographie einem ganz hervorragenden Platz. Eine Aenderung der Namen würde eine schwere Schädigung bedeuten.

(1) *Doliolum* Quoy & Gaimard, 1834.—*Doliolum* ist von Otto 1823 (N. Acta Ac. Leop., v. 11, p. 313) für eine wohl durch *Phronima* ausgefressene *Pyrosoma* aufgestellt worden. Dann ist *Doliolum* von Quoy & Gaimard, 1834 (*Voy. Astrolabe, v. 3, p. 599*) gut beschrieben und jetzt in letzterem Sinne allgemein in Gebrauch. Den bisherigen Regeln nach würde *Doliolum* Synonym zu *Pyrosoma* werden, für *Doliolum* in heutigem Sinne würde ein neuer Name gebildet werden müssen. Der Familienname Doliolidæ würde verschwinden.

(2) *Pyrosoma* Péron, 1804.—1804 beschrieb Péron (*Ann. Mus., Paris, v. 4, p. 440*) *Pyrosoma* und ebenfalls 1804 Bory (Voy. Iles Afr., v. 1, p. 107, nota) *Monophora*. Welcher der beiden Namen der ältere ist, lässt sich nicht feststellen, aber aus Quoy & Gaimard, 1824 (*Voy. Uranie & Physicienne, p. 496*) scheint hervorzugehen, dass *Monophora* älter ist; sie schreiben "Bory—avait donné le nom de monophore à un mollusque, qui depuis a été appelé pyrosome Péron." Es empfiehlt sich den Namen *Pyrosoma* für alle Fälle zu sichern.

(3, 4) *Salpa* Forskål, 1775, und *Cyclosalpa* Blainville, 1827.—Diese beiden Genera sind durch Ihle, 1911 (Zool. Anz., v. 38, pp. 585–589) verteidigt und auch in seine Bearbeitung in "Das Tierreich" (v. 37, 1912; Siehe auch Nota p. 27, von F. E. Schulze) übergegangen. Wir glauben uns mit diesem Hinweise[1] begnügen zu können und erlauben uns noch an die gegenteiligen Aufsätze[1] von Poche (Zool. Anz., v. 32, 1907, pp. 106–109; v. 39, 1912, pp. 410–413) zu erinnern.

(5) *Appendicularia* Fol, 1874.—*Appendicularia* wurde von Chamisso & Eisenhardt, 1820 (N. Acta Ac. Leop., v. 10 (11), p. 362, t. 34 f. 4), für eine arctische, nicht erkennbare Art, aufgestellt. Fol hat 1874 (Arch. Zool. exper., v. 3, notes, p. 49) den Gattungsnamen für die tropische Art *Appendicularia sicula*, die von der arctischen sicher generisch verschieden ist, übernommen und darauf hin hat sich der Name in letzterem Sinne allgemein eingebürgert. *Appendicularia* würde anderenfalls eine Species incerta enthalten und für *Appendicularia* mit der Species *sicula* würde ein neuer Gattungsnamen aufzustellen sein. Der Name der Ordnung Appendicularidæ würde verschwinden.

(6) *Fritillaria* Fol, 1874.—Quoy & Gaimard, 1834 (Voy. Astrolabe, v. 4, p. 306) stellen den Namen Frétillaires auf [(Fritillaria Huxley (1851, Philos. Trans. (London), part 2, p. 595), Fritillaire C. Vogt, 1854 (Mém. Inst. Genève, v. 2, no. 2, p. 74)], identificierten ihn aber sofort mit *Oikopleura* Mertens, 1831. Um den Namen *Fritillaria* zu retten, hat Fol, 1874 (Arch. exper., v. 3, notes, p. 49) ihn in bestimmten von früherem abweichendem Sinne gebraucht, in welchem er sich vollständig eingebürgert hat. *Fritillaria* würde Synonym zu *Oikopleura* und eine Neubennung nötig.

[1] The secretary spends an average of about six (6) hours per week in studies and correspondence for the Commission on Nomenclature, and *he earnestly requests all persons to give full details with full references to every case submitted.* Even slight omissions cause a loss of time. The secretary also respectfully requests that authors submit their cases in typewriting, rather than in handwriting.—C. W. S.

C. Apstein (Berlin), A. Borgert (Bonn), G. P. Farran (Dublin), G. H. Fowler (Aspley-Guise), R. Hartmeyer (Berlin), W. A. Herdman (Liverpool), J. E. W. Ihle (Utrecht), H. Lohmann (Hamburg), W. Michaelsen (Hamburg), G. Neumann (Dresden), C. Ph. Sluiter (Amsterdam), F. Todaro (Rome).

C. W. Stiles,
Secretary of Commission

SPECIAL ARTICLES

A RUST—NEW ON APPLES, PEARS AND OTHER POME FRUITS [1]

For several years the writer has been studying an interesting rust on several cultivated and native species of the pome family. In 1908, the æcial stage of this rust was found on the serviceberry (*Amelanchier florida* Lindl.) and on the thornapple or haw (*Cratægus douglasii* Lindl.); later, the same rust was found on apples, pears, quinces and related fruits, as noted below. The rust on *Amelanchier florida* and *Cratægus douglasii* has been referred to *Æcidium blasdaleanum* D. & H., the telial stage, *Gymnosporangium blasdaleanum* (D. & H.) Kern., occurring on the incense cedar (*Libocedrus decurrens* Tor.).

During the past six years the writer has paid particular attention to this rust for the reason that it seems to be of considerable economic importance. While it occurs rather sparingly on practically all varieties of apples so far observed, it has been found to attack certain varieties of pears very seriously. Quinces are also subject to considerable injury by this rust. In 1910, and again in 1912, this rust was so serious in a block of Winter Nelis pears as to practically destroy 95 per cent. of the crop. The fruit was badly deformed and fully 50 per cent. of the leaves were found infected. The fruit and stems in many cases were completely covered with æcia, distortion and dropping of the fruit being the result. All varieties of pears are not equally susceptible, but both European and Oriental varieties were found affected. Oriental hybrids

[1] A preliminary paper.

also showed infection in a more or less serious degree. This rust is not rœstelia-like, as in the case of the more common apple rust and other rusts whose telial stage is a Gymnosporangium. The incense cedar which bears the telial stage is very common in southern Oregon, being found on the floor of the Rogue River Valley at an altitude of 1,400 feet. The proximity of incense cedar trees to apple and pear orchards is therefore of considerable economic importance.

The hosts upon which the æcia of this rust have been found are:

Malus malus (L.) Britton (apple).

Malus floribunda Sieb. (several varieties) (flowering crab).

Pyrus communis L. (pear).

Pyrus chinensis (Oriental pear).

Pyrus sitchensis (Roem.) Piper (mountain ash).

Malus diversifolia (Bong.) Roem. (native crab apple).

Cydonia vulgaris (L.) Pers. (quince).

Cydonia japonica (Thumb.) Pers. (Japan quince).

Amelanchier florida Lindl. (serviceberry).

Cratægus douglasii Lindl. (thornapple or haw).

Culture records and final proof will be given in a detailed paper which will be published in the near future. This preliminary paper is given simply as a statement as to what has been found.

P. J. O'Gara

Pathological Laboratory,
Medford, Oregon,
September 1, 1913

A POSSIBLE MUTANT IN THE BELLWORT (OAKESIA SESSILIFOLIA) WHICH PREVENTS SEED FORMATION

The sessile-leaved bellwort (*Oakesia sessilifolia*) is used in many elementary classes in botany as a convenient type to illustrate the Lily family. The normal pistil with a single detached stamen is shown in Fig. 1, magnified three diameters. There are three stigmas terminating styles which are free at their extremities. In class material collected late in the spring of 1912, flowers were discovered with pistils of the form shown in Fig. 2. The pistil is shorter and thicker than in normal flowers but the essential abnormality consists in the transformation of the three stigmas into functional stamens, each with a pair of pollen sacs. Aside from the hermaphroditism of the pistil, the abnormal flowers do not differ in appearance from typical blossoms and bear their full quota of six normal stamens. The stigmatic anthers are well formed and filled with perfect pollen indistinguishable from that produced in typical anthers. In three per cent. grape sugar as well as in cane sugar, pollen from the two types of anthers show an equally high per cent. of germinations. Eleven attempts were made last spring to pollinate normal pistils with pollen from abnormal flowers, pollen both

Fig. 1.

Fig. 2.

from stigmatic and from typical anthers being used, but in no case did seed set. Very few capsules were found with seed this last season, however, on untreated plants. In the spring of 1913 search was made for flowers with stigmatic anthers. Of 305 flowers examined from a woodlot which comprised about five acres, there were only 13 with stigmatic anthers. Twelve were found in a patch about 10 ft. square and a single specimen 100 ft. distant. A single flower with stigmatic anthers, however, had been found the previous year about 200 yards from the patch just mentioned. Some few of the flowers classed as normal had rudimentary pistils though normal stamens. One hundred and thirty-two flowers from outside this woodlot were found to be normal. The total number is not sufficient to warrant one in making a suggestion as to the probability of the abnormal form having originated in this single locality.

The transformation of stigmas into anthers seems to completely block the possibility of fertilization, for the ovules which are laid down in deformed pistils have never been found to develop. The abnormality described, therefore, has a double interest. It not only shows an alteration in the products of an organ with a highly stereotyped sexual development, but it also offers an instance apparently of a mutation directly unfavorable to the reproduction of the species. In consequence the subject has seemed worthy of further investigation and the present note is to call attention of botanizers this spring to the possible occurrence of the abnormality in other localities. We should be glad to correspond with any one finding abnormal flowers of the bellworts.

A. F. Blakeslee,
A. F. Schulze

Connecticut Agricultural College,
Storrs, Conn.

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 470th regular meeting of the society held December 16, 1913, James Mooney, of the Bureau of American Ethnology, delivered an address on "The Gaelic Factor in the World's Population." The speaker dealt chiefly with the Irish Gaels and drew a distinction between the Irish of native Gaelic stock and the unassimilated alien element massed in several of the northeastern counties as the result of the "Plantations" under James I. and Cromwell. This alien element was of English and Lowland Scotch stock, with a slight Highland Gaelic infusion, Protestant in religion and mostly Unionists in politics, while those of the old native stock were as solidly Catholic and Nationalist. Speaking broadly, in Ireland the Catholics represent the original Gaelic stock; the Episcopalians, those of English stock, and the Presbyterians and Methodists, those of Scotch origin, constituting respectively about 74, 13 and 11 per cent. of the total population. The present Gaelic race of Ireland is a blend of the Gael proper, a Keltic people who arrived in the country probably from northern Spain about 1,000 B.C., and of all other races who preceded or followed them up to the end of the thirteenth century, including the neolithic man, the unknown megalith builders, the dark-haired Firbolg, the Picts, Danes, Normans and Welsh. The Irish immigration to the American colonies previous to the Revolution was mainly of the alien Scotch and English element, known sometimes as Scotch-Irish. The Gaelic Irish immigrants did not begin to arrive in any great number until after the war of 1812, excepting in Maryland.

The wars growing out of the Reformation and the Stuart contests reduced the Irish race from an estimated two and a half million in 1560 to about 960,000 at the end of the Cromwellian war in 1652. In 1845 it reached its maximum estimate of 8,500,000. Then came the great famine of 1846–47. Within three years nearly 1,500,000 perished of hunger or famine fever. This started the great flood of emigration by which Ireland has lost virtually one half its population within sixty years. In 1911 it stood at 4,390,219, the lowest point reached in over a century. Owing to governmental and economic conditions this decrease has been chiefly at the expense of the old native Gaelic stock rather than the Planter stock, the Gaelic percentage, as indicated by the religious statistics, having fallen from 83 to 74. In the sixty years ending March 31, 1911, according to the official British figures, 4,191,552 emigrants left Ireland, or nearly as many persons as are now living in the country. About three million of these came to the United States, the total Irish im-

migration to this country from 1821 to 1900 being, officially, 3,871,253. From 1821 to 1850 the Irish constituted nearly one half of all our immigrants. Previous to the Revolution the "Scotch-Irish" immigration was so great than in an official Parliamentary inquiry in 1778 it was asserted that nearly one half of the American Revolutionary Army was of Irish origin. Since 1870 the number of Irish-born in the United States has steadily decreased, by death and dwindling immigration. According to the census of 1910 there are now in the United States of Irish birth or parentage, 4,504,360. This does not include any of the 811,000 non-French Canadians in the United States, of whom a large proportion are of Irish blood, or any of the 876,000 coming from England, of whom also a large number are of Irish origin. Neither does it include any of the 1,177,000 American born "of mixed foreign parentage," including such parentage combinations as Irish and Germans, which alone probably runs above fifty thousand. Among the states, New York stands first with 1,091,000 of Irish birth or parentage; Massachusetts second, with 633,000, and Pennsylvania third, with 570,000. For all these figures it may be asserted that more than four fifths are of Gaelic stock.

By the latest British census, 1911, the population of Ireland was 4,390,219, of whom all but 157,037 were native born. Of the native born abont 74 per cent. or 3,245,000 represent the old Gaelic stock. By the same census there were 375,325 persons of Irish birth then living in England and Wales, while an unofficial estimate pnts those in Scotland at about 220,000 or nearly 600,000 for the whole island, which with the children of Irish parentage would probably total at least 1,500,000. The same census gives 139,434 Irish born to Australia, or perhaps 350,000 of Irish blood. South Africa and the other British colonies, exclusive of Canada, have (estimated) 100,000 of the same stock, while Canada has in round numbers 990,000 of Irish birth or parentage, of whom about 750,000 are of Gaelic origin, as indicated by religious denomination. Outside the countries already named, Argentina has some 15,000 Irish born and the rest of Latin America possibly as many more, with perhaps another 15,000 or 20,000 scattered over the rest of the world. To sum up, the total Irish-born population throughout the world is now abont 6,875,000, or abont 1,625,000 less than the population of the home country alone in 1845, while the whole number of unmixed Irish blood may be abont seventeen million, of whom nearly fifteen million are of Gaelic stock. The total Gaelic population—Irish, Scotch and Manx—of fairly pure stock and racial identity, in every part of the world, probably numbers close to twenty million.

AT a special meeting of the society held on January 6, at the National Museum, Dr. Truman Michelson, of the Bureau of American Ethnology, delivered an address, "Notes on the Fox Indians of Iowa." Their own native name is Meskwa'ki'ᴀg', "Red-Earths"; the French name, *les Renards*, is derived from the appellation of a single gens, Wāgō'ᴀg', "Foxes"; the English name "Foxes" is a translation of the French *les Renards;* the term "Outagamies" (and variants) is derived from the Ojibwa Utᴀgāmig, "they of the other shore." Their closest linguistic relations are first with the Sauk, then the Kickapoo, then the Shawnee, and then the so-called Abnaki tribes. They are also comparatively close to the Menominee and Cree as compared with the Ojibwa, Otawa and Potawatomi. The thesis that the Foxes were once an Iroquoian people and subsequently took up an Algonquian dialect can not be substantiated. There is presumptive evidence that the Foxes were once in the lower Michigan peninsula. However their proper history begins in the last half of the seventeenth century in Wisconsin on the Wolf and Fox rivers. After the famous Black Hawk war, the Sauks and Foxes sold their remaining lands in Iowa and agreed to remove to Kansas. Nevertheless small bands of the Foxes returned continually to Iowa. In 1856 the Iowa legislatnre passed a bill enabling the Foxes to settle in that state. Accordingly they purchased land with their own money, near Tama, Iowa. From time to time this has been added to till they now own about 3,000 acres. The main body of the Foxes did not leave Kansas till the outbreak of the Civil War. In 1896 the state of Iowa relinquished jurisdiction of the Foxes to the federal government, and at the same time certain claims of the Foxes against the Sauks were adjusted. There are some Foxes enrolled with the Sauks of Kansas and Oklahoma; the present population of those in Iowa is about 356.

AT the 471st meeting of the society, held January 20, 1914, at the National Museum, Mr. William H. Babcock spoke on "The North Atlantic Island of Brazil," illustrating his address with lantern slides of early maps. Attention was called to three Brazils, that of Sonth America, the Mount Brazil in Terceira and that of the western Ireland peasantry who still believe in a great land called Brazil or Breasail west of them in the

ocean. This last is probably the original Brazil, from which the others received the name, it being identical with that of a mythical pagan Irish hero and also practically with that of St. Bresal. Outside of Ireland it first appears in the expression "grana de Brasile"—grain of Brazil—in a commercial treaty of Ferrara, Italy, dated 1193, and another Italian document of 1198. The speaker suggested that the primary Brazil, west of Ireland, may have been the region surrounding the Gulf of St. Lawrence. The maps of Dalorto 1325 and Dulcert 1339 were presented as the first showing Brazil, a nearly circular figure west of southern Ireland. The corroborative testimony of the Norse sagas as to Great Ireland and the opinion of Dr. Storm and Dr. Fisher identifying Brazil with Markland are best supported by the Catalan map of 1480. The general argument was that some who spoke Irish reached the St. Lawrence Gulf region at a very early period and gave it the name Brazil.

AT a special meeting of the society held February 3 at the National Museum, Miss Frances Densmore, of the Bureau of American Ethnology, read a paper on "Sioux War Songs," using the stereopticon, the phonograph and vocal selections in illustration of her theme. A number of native drawings of war incidents were shown. War among Indians was not an occasional calamity, it more nearly resembled a steady occupation. To the individual it offered a career. A man could best become rich and honored by going to war. A man was rated according to his generosity, and having given away his goods there must be some way of securing a new supply of wealth. A war party afforded this opportunity. War was a means of revenge, was for the defence of the home and was the protection of the hunting ground which meant the food supply. A war party traveled far and brought back strange tales of distant lands. New customs were frequently introduced into the tribe as a result of war expeditions or the taking of captives. Only a successful warrior could belong to the leading societies of the tribe, with their special tents for meeting, their feasts and their parades. But the greatest reward was the right to sing of one's valor at the assemblages of the tribe.

DANIEL FOLKMAR,
Secretary

THE NEW ORLEANS ACADEMY OF SCIENCES

THE annual meeting of the Academy was held in Tulane University on Tuesday, March 17, with President Dr. Isadore Dyer in the chair and a full quorum of fellows and members. The following resolutions were passed upon the death of Dr. Alcee Fortier:

WHEREAS, By the death of Dr. Alcee Fortier the New Orleans Academy of Sciences has lost one of its oldest fellows, one who took an active part in the reorganization of the Academy in 1886, was its corresponding secretary from 1886 to 1890, and published a valuable contribution on Romance Philology in the proceedings of 1888,

Resolved, That we, the fellows and members of the New Orleans Academy of Sciences, do hereby express our sincere appreciation of his most valuable services to this organization, not only in his official capacity as secretary, but also as a scholarly contributor to its proceedings and furthermore our deep sense of the loss which the Academy has sustained by his death.

Resolved furthermore, that a copy of these resolutions be incorporated in the minutes of the Academy and that copies also be sent to his family, to SCIENCE and to the press of this city.

Officers for the ensuing year were elected as follows:

President—W. B. Gregory, professor of experimental engineering, Tulane University.

First Vice-president—Gustav Mann, professor of physiology, Tulane University.

Second Vice-president—W. A. Read, professor of English, Louisiana State University.

Secretary—R. S. Cocks, professor of botany, Tulane University.

Treasurer—Ann Hero, professor of chemistry, Sophie Newcomb Memorial College.

Librarian-Curator—J. H. Clo, professor of physics, Tulane University.

Corresponding Secretary—Pierce Butler, professor of English, Sophie Newcomb Memorial College.

The scientific program consisted of the following papers: (1) "Some Theories of Valence," by H. W. Moseley. The paper traced the development of the doctrine of valence from a historical view-point. Some of the modern theories were then taken up in more detail, especially the theories of Abegg, Spiegel and Arrhenius, Ramsay, Friend, Thompson and Werner. The paper closed with mentioning some recent observations of Bray and others upon valency and tautomerism. The paper was discussed by Dr. P. B. Caldwell. The second paper was by R. S. Cocks calling attention to several interesting facts connected with plant distribution in Louisiana, dealing especially with the eastern portion of the state.

R. S. COCKS,
Secretary

SCIENCE

FRIDAY, MAY 1, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE STUDY OF HUMAN BEHAVIOR[1]

MY part in this symposium must be that of the comparative psychologist who, while professionally engaged in the experimental study of the behavior of lower organisms, is keenly interested in human behavior and in the development of methods by which it may be profitably studied. I propose, in this discussion, to try to bring some of the experiences of the student of the behavior of animals to bear upon the problems which the eugenic investigator meets. Especially I shall attempt to indicate the necessity for an analytic procedure on the basis of carefully wrought out methods of experimental control and observation, and the thorough-going study of the components of human responses to situations rather than of complexes such as are actually presented to us in the behavior of human beings.

Human behavior is only a part, albeit a most important part, of the materials of the general science of organic behavior. It presents essentially the same kinds of problems as does the behavior of any other mammal; and it must be studied by methods similar to, if not actually identical with, those employed by the student of infra-human behavior. I should be in-

[1] The substance of the writer's contribution to a symposium on the Study of Human Behavior at the Conference on Eugenics, held at Cold Spring Harbor, Long Island, June 19 and 20, 1913. Being Contributions from the Psychopathic Hospital, Boston, Massachusetts, No. 25 (1913. 25): previous Contribution, P. H. Contributions 1913. 24, was Robert M. Yerkes: "Comparative Psychology: A Question of Definitions." *The Journal of Philosophy, Psychology and Scientific Methods*, October 9, 1913.

clined to go still further in maintaining that a student of comparative psychology, or the behaviorist in the wide sense, is admirably fitted, by his experience in dealing with varied forms of behavior, by his knowledge of the genetic relations or developmental history of organic behavior, and by the ingenuity in devising and using experimental methods which his work forces him to acquire, to formulate problems in human behavior and to suggest methods of solving them.

There are at least three valuable points of view from which the behavior of man may be studied: the psychological; the physiological; and the pragmatological.[2] The first inclines the observer to an analytic study of activity in its relations to the ideas, motives, purposes and ideals of the organism; in a word, to a study whose goal is the description of behavior as an expression of will. The second disposes the investigator to seek definite knowledge of the functions of motor organs and of the relations of those mechanisms to other bodily organs and processes. From this point of view, the organism is studied as a living thing, influenced by environment and reacting upon it. The third directs him to the products of organic activity, as keys to the meaning of conscious behavior. It may reasonably be maintained that the understanding of the behavior of any organism, and most of all that of man, is conditioned by reliable and reasonably complete knowledge of the experiences of the organism, of its life processes, including its complex as well as its simple forms of behavior, and of the products or results of its bodily activities. We may consider fortunate those students of human behavior who are able to take, in turn, as occasion demands or as opportunity makes possible, these three points of view, for we must recognize that man is a self-conscious being who exhibits varied and complex activities and at the same time produces works of science, industry and art which are of deep psychological significance. This, however, is merely equivalent to the statement that human behavior may be clearly understood only if viewed in its relations, on the one hand, to its structural conditions, and on the other, to its purposes and results.

The history of science indicates that man has been surprisingly slow to come into close quarters, in a strictly scientific manner, with his own behavior. Of psychological, neurological, ethnological and archeological facts we to-day have an abundance. But we know relatively little concerning the facts and laws of human activity. This is true, I believe, chiefly for two reasons. First, because consciousness, presenting as it does a perennially puzzling problem in its relations to body, has absorbed attention; and, second, because the results of human behavior have proved more engaging to most observers, even to most scientific observers, than the behavior itself. To-day, a change is evident, for here and there "human behavior" has become an object of scientific interest. Sometimes this interest is inspired by practical problems; sometimes, by the desire for scientific knowledge. Recently, there have appeared several books[3] which, although dealing with

[2] We lack a term to designate the point of view of the scientific student of the results or products of activity, such, for example, as the abodes of animals or of man, works of art, scientific inventions, etc. I have designated this point of view as pragmatological, in the absence of a more suitable term.

[3] Among these may be mentioned "The Science of Human Behavior: Biological and Psychological Foundations," by Maurice Parmelee, New York, 1913; "The Fundamental Laws of Human Behavior; lectures on the foundations of any mental or social science," by Max Meyer, Boston, 1911; "Introduction to Social Psychology," by William McDougall, London, 1908.

the general subject of man's behavior, are indicative rather of the realization of the need of knowledge than of the existence of such knowledge. Without exception, such general discussions as the writer is familiar with display our ignorance of the facts of behavior and of the principles underlying them and serve rather as arguments in favor of the systematic study of this group of phenomena than as satisfactory treatises.

The behaviorist, whether he be physiologist or psychologist at heart, seeks, first of all, accurate knowledge of the facts of behavior. His task it is to analyze behavior-complexes, to discover their conditions or causes, to formulate the laws of their appearance, and to point the way to their control. It matters not to him whether his subject happens to be a horse, an ape, or a man. He adapts his methods of investigation to the problem and the subject in hand and proceeds to gather data. It is characteristic of the recent experimental work in behavior that reactions to simple or complex situations should be broken up into smaller and smaller part processes, and the characteristics of these processes as well as their relations, studied minutely, persistently, accurately.

Our time-honored classification of activities as reflex, instinctive, impulsive, habitual, voluntary, is no longer in favor. Indeed, the speculative discussion of the characteristics of different types of activity and attempts to formulate definitions which shall render these types mutually exclusive have to-day given place to systematic searching for the characteristics or attributes of acts and groups of acts, and for genetic descriptions thereof. Only recently, it must be confessed, have we fully realized that an instinctive act is something to be observed and reobserved under varied and rigidly controlled conditions; something to be studied in its origin and development; something to be created, if possible, by the control of conditions of organic behavior, rather than something merely to be talked about or defined in abstract terms. The older literature of instinct is vague, general, speculative. The newer is definite, concrete, observational. And what is true of our studies of instinct is true, likewise, of our studies of the various senses and of habits.

It is rather late in this discussion to define behavior, yet an attempt to do so may serve to correct certain misimpressions which seem not uncommon. The term, as used by the scientist to-day, is inclusive not merely of those gross and obvious activities exhibited by man in common with the other animals, but of hidden organic processes. The behaviorist is interested quite as much in reflexes, which might ordinarily be relegated to physiology, as in habitual, or instinctive, or voluntary acts. But he is interested, also, as much in the complex forms of behavior, known as conduct, as in the simpler expressions of human intelligence. Indeed, even the most complex moral and religious forms of activity are regarded by him as material for scientific study.

A strictly scientific study of the varieties of human behavior demands, first, the formulation of problems, for advance comes slowly and uncertainly unless the investigator can definitely formulate his task. It demands, further, thorough knowledge of the methods of physiology, of psychology, of physics, and of chemistry, and ingenuity on the part of the experimenter in adapting these methods to his immediate needs. Finally, it demands familiarity with the facts of behavior in other organisms, in order that the comparative method may be made to lend abundant aid.

Noteworthy changes have occurred in the study of behavior during the past twenty

years. Then, observation was naturalistic, general: now, it is experimental, specific. Most obvious and most important of the changes is the development of methods by which the conditions of observation may be controlled and the results precisely recorded. The older work was, on the whole, crude, inconclusive, wasteful of time, leading to few safe generalizations; the newer, by contrast, is precise, carefully controlled, and tending to lead to the formulation of laws. It is, of course, desirable that we recognize that not all observation can be conducted under experimental conditions, that the naturalistic method in the study of human behavior as also in the study of animal behavior has its proper and important place. We should gladly recognize its values, while insisting upon the importance of supplementing it by the experimental study of the same phenomena.

But the practical-minded person has doubtless been asking, throughout this introductory discussion, of our topic, "How may the reactions of a person be scientifically studied? Is it possible, ordinarily, to subject a human being to such conditions of observation as are used in experiments with other animals?" A few examples from studies of human and infra-human behavior will serve as an answer to these questions.

One of the most interesting aspects of organic activity is its modifiability. We designate this as habit-formation. Now, it happens that in a great variety of organisms the formation of habits has been studied experimentally. In the case of the dancing mouse,[4] for example, I investigated the relation of rapidity of habit-formation to certain external conditions. With an apparatus so arranged that the mouse could choose as its route through the experiment box either a dark or a light passageway, I determined the number of experiences necessary in order that the animal should learn that, no matter what the spacial relations of the passageways, only the light one could safely be chosen as a way of egress, since each time the dark passageway was entered a disagreeable electric shock resulted. It was the problem of the observer to discover how quickly, under a given set of conditions, the mouse would learn always to avoid the one passageway and to seek the other. In this experiment, which was so conducted that strictly comparable results were obtained from several individuals, it was first ascertained that the less the difference in lightness of the two passageways, the longer it took the mouse to learn to choose correctly. Next, it was determined that the rapidity of learning varied with the strength of the electric shock, which was regularly given as punishment for mistakes. When the passageways differed markedly (discrimination easy), the stronger the shock the more rapid the learning. When the passageways differed slightly (discrimination difficult), beyond a certain point, increase in the strength of the shock delayed the learning process. When the passageways differed by an intermediate amount, it appeared that an intermediate strength of stimulus was most favorable to habit-formation. From these observations, it was possible to deduce the following law for the behavior of the dancing mouse: As the difficultness of visual discrimination increases, that strength of electric stimulus which is most favorable as a condition for the acquisition of a habit tends to approach the threshold.

In this investigation, we have, first, a definite problem; second, a reasonably large number of observational data (facts of be-

[4] Yerkes, Robert M. and Dodson, John D., "The Relation of Strength of Stimulus to Rapidity of Habit-formation," *Journal of Comparative Neurology and Psychology*, 1908, Vol. 18, p. 459.

havior), and, third, a law of behavior for the particular organism in question. In effect, what I did with the dancing mouse might be done with human subjects, should it seem desirable to gain definite knowledge of this aspect of habit-formation. As it happens, precisely the kind of knowledge of human behavior which such experimental methods yield is necessary, if we are ever to have a thoroughgoing science of human behavior which will enable us to deal with our fellows effectively.

Another illustration may be taken from the study of imitative activity. It is generally recognized that imitation may be studied experimentally in any organism. But up to the present most observations of this group of phenomena have been casual, and our opinions concerning the importance of imitation in any organism are quite likely to be based upon insufficient or inaccurate information. With sparrows, canaries, mice, rats, cats, dogs, monkeys, experiments have been made to determine the nature and extent of imitative reaction, and there is no obvious reason why the methods of the behaviorists should not be adapted to the study of the imitative tendency in human beings.

In order to exhibit, in its general features, a method of studying imitation experimentally, we shall consider investigations of this aspect of behavior in monkeys.[5] The observer, first of all, seeks for a number of acts or series of acts which his animals either can not learn to perform of their own initiative or learn with extreme difficulty. Such acts are most readily discovered in connection with artificially arranged situations, as, for example, in connection with puzzle or problem boxes and similar experimental devices. He then teaches one animal to perform an act and thereafter, under definitely describable and constant conditions, he permits another animal to observe the behavior of the first. Any tendency for the second animal to imitate the first, or to modify its behavior in accordance with the activities of the first, is noted. Thus, by repetition after repetition of this sort of experiment, the observer strives to get definite knowledge of the nature and extent to which the behavior of one animal influences that of its fellows. It is, of course, necessary in such an experiment to work out a method carefully and to make all observations under carefully controlled conditions. It is necessary, also, to measure as precisely as possible several aspects of the behavior of the observing individual, and thus to depend not upon general impressions, but upon records which can not be influenced by any bias on the part of the experimenter.

Such experimental studies as those of Watson and Haggerty have proved that certain monkeys imitate much less generally than is commonly supposed. And further, that they imitate seldom, if ever, in the purposive manner in which man imitates. It seems that although they influence one another markedly in their behavior, this influence is chiefly a matter of the directing of attention. The imitation of means or of ends in a voluntary and wholly conscious manner rarely appears among the mammals below man.

An illustration from actual experimental work which clearly indicates the need of analyzing behavior complexes and of dealing quantitatively with simple bits of behavior is furnished by some recent work which the writer has done with rats. It was his task to try to discover the modes of heredity of savageness and wildness in rats.

[5] Haggerty, M. E., "Imitation in Monkeys," *Journal of Comparative Neurology and Psychology*, 1909, Vol. 19, p. 337; Watson, B., "Imitation in Monkeys," *Psychological Bulletin*, 1908, Vol. 5, p. 169.

In order to accomplish this task, it was necessary to analyze savageness and wildness. This meant discovering those acts or organic processes which, taken together, mean to the observer savageness or wildness. The first result of observation was that biting, squealing, struggling to escape, or attacking the experimenter, and process of excretion, appeared as important elements of savageness. The experimenter, relying upon these elements, measured, roughly, the savageness of a large number of individuals, arranging them according to their behavior in six grades, designated 0 to 5. On the basis of this obviously crude preliminary work, certain facts indicative of the mode of transmission of savageness and wildness were ascertained.[6]

In yet other observations on rats which involved the comparison of two groups, stock individuals and closely inbred individuals, it appeared that the behavior of the two groups, in the face of certain experimentally arranged situations, differed greatly. This, upon careful observation, the experimenter was able to attribute to differences in temperament. The stock rats were rather active, energetic, quick moving, whereas the inbred animals were more stolid, slow and deliberate. In order that the reactions of these individuals in various experimental situations be properly interpreted, it is essential that the experimenter obtain knowledge of their temperamental character, such, for example, as degree of nervousness or of timidity, of savageness or wildness, quickness of response, persistence, energy and so on through the list of aspects of behavior which, looked at as a whole, might be considered the temperament of the animal. The point which I am trying to emphasize is this. If we are to work effectively, with human beings or other animals, we must analyze the concrete behavior of the organism's every-day life into simpler processes and then study these processes, one by one, by means of methods which shall enable us to measure them fairly accurately and describe them with corresponding accuracy and precision.

The application of these observations in the work of the eugenics investigator are obvious, for the latter, in dealing with human behavior, first of all observes complexes. If he is content to continue to observe these complexes and to try to study their behavior in heredity, he may or may not obtain scientifically valuable results. But in any event, his safer course by far is to deal with part processes, first to analyze his complexes and then to select what seem to be the most important elements and carefully study their characteristics and their behavior as possible inheritances. From his own experience, the writer is inclined to urge that it is always safer to deal with items of behavior than to attempt to deal with behavior in a large or wholesale manner—safer, for example, to study capacity for a particular sort of musical expression, singing or violin playing, than to study musical ability in general.

Were we to present more examples from actual work, we might describe methods of studying distance orientation, visual discrimination, other aspects of habit-formation, the permanency of habits, instinct and emotion, in animals, but it will suffice for our present purposes to describe briefly two methods of analyzing behavior which have recently been devised. These methods, unlike those in general use by students of animal behavior, are applicable alike to man and to other mammals, even to birds as well. They were, indeed, planned with the idea that they should make possible the comparison of reaction-types or reactive

[6] Yerkes, Robert M., "Heredity of Savageness and Wildness in Rats," *Journal of Animal Behavior*, 1913, Vol. 3, p. 286.

tendencies in birds and mammals, and all these in turn with the tendencies displayed by human beings, either mature or immature, either normal or abnormal.

The two methods referred to are the quadruple choice method of Hamilton[7] and the multiple choice method of Yerkes. The Hamilton method places the subject in an experimental situation which may be reacted to in many different ways and with varying degrees of satisfactoriness or adequacy. The subject of the experiment is placed in a small room on one side of which there are four doors. From experience, he learns that he may escape by one of the doors, and only one, but which of the four to choose is his problem, for it is the plan of the experimenter to lock, in a given trial, the door through which the animal escaped in the previous trial and two others. Any one, then, of three doors may be unlocked in a given trial. The animal has absolutely no way of predicting which is unlocked. The general question is, then, how will a given type of organism or a given individual meet this situation? What habitual manner of meeting it will be acquired? How will the modes of reaction displayed by a child compare with those of an adult; of an ape, with those of a man?

The Yerkes method is similar in purpose to that of Hamilton, but it offers, in the opinion of the writer, somewhat more satisfactory opportunity to evaluate and compare results. It consists, essentially, in the presentation to the subject—bird or mammal; young or old, normal or abnormal—of a bank of twelve keys numbered from left to right, one to twelve. The subject is given to understand, verbally, or through actual experience with the apparatus, that pressing some one of the twelve keys will yield a certain desired result, such, for example, as the displaying of a picture, the presentation of food, the ringing of a bell. Success in the experiment means, simply, pressing the key which brings the desired result. The experimenter sees to it that in no two successive trials is the same key the one to be operated. He is, further, able to push back out of sight any number of keys and thus to present to the subject as few as one or as many as twelve.

Let us assume that in a given experiment the observer decides that the key the fourth from the left shall always be the "right" one. It then becomes the task of the subject of the experiment to suit his reactions to the number chosen by the experimenter. Only if he discovers the guiding idea of the experimenter can he succeed, trial after trial, in touching the right key at first. This method may be varied almost indefinitely in difficultness, and it may be made to elicit numerous reactive tendencies.

It is obvious that both of the methods thus briefly described above are attempts to elicit general reactive tendencies rather than to analyze reactions minutely and carefully. The methods are indeed intended to bring into clear light those modes of responding to a given situation which are characteristic of different types or conditions of living beings, and thus to furnish a basis for a profitable comparison of reactive tendencies.

I can not conclude this discussion without referring for a moment to a question which is frequently asked and which surely must have been in the minds of some of my hearers; namely, why is it that the behaviorist deals so often with the activities of the lower animals and so seldom with those of man? The question is pertinent, and the reasons, as I see them, are significant. They are chiefly two: in the first place, most lower animals are easily obtained,

[7] Hamilton, G. V., "A Study of Trial and Error Reactions in Mammals," *Journal of Animal Behavior*, 1911, Vol. 1, p. 33.

kept in confinement, bred and reared for experimental purposes; in the second place, many of them, in comparison with human beings, can be readily controlled throughout their lives and subjected to experimental conditions, in definite and measurable ways. Because, then, of the availability and controllability of lower animals, it is far easier and more satisfactory to make preliminary, exploratory and problems defining observations on their behavior rather than on that of man. It is further to be considered that the time of a human subject is worth infinitely more than that of an infra-human subject. On the whole, it seems clear that we work to advantage in the early stages of our science of behavior by letting the lower animals help us to the formulation of our problems and the development of our methods. Once fairly oriented and reasonably skilled in our technique, we may, with better effect, attack the problems of human behavior.

The above considerations lead to yet a further reflection concerning the relation of the study of the behavior of infra-human organisms to that of man. To the writer, it seems of preeminent importance that we prepare for rapid advance in our knowledge of human behavior by the systematic, thoroughgoing study of the behavior of some one or more of the anthropoid apes and of the higher monkeys. These creatures are nearest of kin to man, alike in structure and in behavior, and it is quite as surprising as it is unfortunate that we should know so little definitely concerning their mental characteristics or the facts and laws of their behavior. It may fairly be urged, I think, that no task comparable in importance with that of the systematic study of the instincts and intelligence of the apes lies before the behaviorist. Because of this strong conviction, I wish to present the following plan, which is quite as much in the interest of a study of man's behavior as of that of the anthropoid apes themselves.

It is proposed that a permanent station be established in some tropical country (Borneo and Jamaica would seem well worth considering) where, under favorable conditions, certain of the apes can be bred, reared and observed. Year after year, the staff of such a station should conduct systematic experiments with these animals and record observations of their behavior in their semi-wild state. There should be equally good opportunities for naturalistic and for experimental work, for the study of the development of forms of behavior, and of the relations of particular acts to definite environmental or other conditions. The value of such work would depend largely upon its continuance over a long period of time and upon the possibilities of breeding the animals and of observing the development of activities. To any one interested in the study of behavior, an elaborate program of research will at once present itself. It is wholly unnecessary, at this time, to enter into the details of such a plan. Suffice it to say that several biologists and psychologists, who have been consulted concerning it, enthusiastically approve of the proposal and earnestly hope that such a station may be established.

This plea for special and unique facilities for the systematic study of the apes is presented to you because upon students of genetics, eugenic investigators, and sociologists, quite as heavily as upon behaviorists and psychologists, must rest the responsibility of carrying out any such proposal. Moreover, I can urge the plan upon your consideration with enthusiasm because I fully believe that this apparently roundabout way to knowledge of the laws of our own behavior is in reality the most direct and desirable way. Certain it is that if

we neglect our present opportunities to study the anthropoids, our children's children will condemn us for neglecting invaluable opportunities. To-day, the chimpanzee, the orang-outang, the gibbon, as well as many species of monkey, are at hand for observation. A generation or two hence, many of the primates may be extinct. Should we not, in the interests of genetics, whether we be concerned primarily with problems of structure or of function, see to it that we adequately use, for the purpose of advancing human welfare, our present primate materials?

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SWEATING THE SCIENTIST[1]

IN the four last numbers of *Science Progress* a notice has been inserted asking for information on the emoluments of scientific workers; and a considerable number of interesting replies have been received. They are not numerous enough to form a basis for any statistical investigation of the subject—which it is hoped may be attempted later on when more evidence has been collected; but the replies received, combined with information which may be otherwise obtained, suffice to prove the low scale of payment given throughout the British Empire for such work.

The term "scientific worker" includes, according to the notice, all salaried workers—that is, men of all grades, namely, research students, assistants, professors, directors of laboratories, and other fully paid workers, and also half-time and whole-time workers. The duties generally include teaching and the administrative charge of university departments, museums and special laboratories. The lowest scale of pay mentioned in the replies is £85 a year for half-time work; but it is notorious that a large number of such workers, especially in medical subjects, are paid nothing at all. The pay of junior posts (which are also sometimes unpaid) rises from about £120 to £200, £250 and, rarely, £300 a year. These are of course not so important as the upper scales of pay for full-time professorships and permanent appointments. For the latter, the highest pay mentioned in the replies amounts to £850 a year, with a small pension (Ceylon). The next highest are salaries of £750, both in South Africa, and one of £500 in Canada, with small pensions generally contributed to by the holders of the appointments. It is well known that many professorships in Britain yield £600 a year, with very small contributory pensions. In no cases do there appear to be any arrangements for family pensions in the event of the holders' death—such as are often provided in the public services; nor insurance against illness or accident. Notoriously, very few even of the highest posts receive a salary touching or exceeding £1,000 a year; and in nearly all cases the pensions are contributory and are of a very small amount—retirement being often compulsory at the age of 60 or 65 years. Progressive rises of pay are also seldom provided for; so that a man who obtains an appointment when comparatively young can seldom hope for any increase during the rest of his life. Lastly, payment is laid down at many universities according to a flat rate, or according to fixed endowments which depend upon the funds originally allotted—so that no provision is made for retaining specially good men. In some cases holders of fully paid appointments are able to increase their emoluments by outside work. Many medical professorships are quite unpaid.

The rates of pay must be judged by the locality in which they are given. Thus £750 in South Africa is worth very much less than that sum in Britain, the cost of living being perhaps twice as great. A correspondent from Canada remarks that a salary of £800 a year in England is equivalent only to about £600 a year there, and is not sufficient for a professor. "A member of a learned community," he says, "can not live in a back street like a laborer, and if he takes an unfurnished house

[1] An editorial article printed in the April number of *Science Progress in the Twentieth Century: A Quarterly Journal of Scientific Work and Thought*, edited by Sir Ronald Ross.

in a good locality here the rent will be about a quarter of his income. . . . The smallness of income results, in my case, in my being unable to buy books, subscribe to scientific journals, or join all the learned societies I ought, or to travel to see other universities." Similar complaints are made from elsewhere; and the conditions in Britain are notorious.

Of course, very junior posts are generally financed by scholarships; and are naturally not highly paid because the holders are young men who are, practically, being apprenticed to their labors. The senior posts are those which must be considered in drawing any comparison between the payment for scientific work and other lines of effort; and even in this respect other conditions besides the payment must be taken into account. On the whole, however, such comparison leads to a very unfavorable conclusion regarding the present payment of scientific workers in Britain. It is bad, compared even with the Church. In middle posts, the salaries may be slightly higher; but in academical life the incumbents are obliged to live in towns and are rarely provided with housing. The highest appointments open in science certainly seem to be paid much less than the highest appointments in the Anglican Church—though the latter figures can not be very easily ascertained; and, at least, no scientific men have a seat in the House of Lords by virtue of their office or work. The highest salaries for scientific work are very much less than those given in the Army and Navy—which reach to £4,000 or £5,000 a year, and probably more when certain allowances are added. The scientific and academical sides of the medical profession show a similar state of affairs when compared with the clinical side—the incomes of the former seldom if ever exceeding £1,000 a year, while those of the latter are well known to run to many times that amount, especially in surgery. Compared with the law, science stands nowhere at all in Britain, either in payment or in position. The disparity is still greater in comparison with "business"; and the enormous fortunes made in innumerable directions by manufacturers, shipowners, retail and wholesale traders, vendors of registered articles, financiers, and so on, would in many single cases cover the whole funds allotted to science throughout the great British Empire. Even certain branches of art, such as the drama, singing and acting, have a large advantage compared with scientific work.

It is in no grudging spirit that men of science will draw such comparisons. That good pay should be given for good work is an elementary principle governing all lines of effort; but another principle must be held in view—that, if possible, payment should bear some proportion to the value of the kind of work done. We pay an architect or a general more than we pay the bricklayer or the soldier, because the labors of the former are the more important; and the same principle should carry weight in comparisons of the emoluments of the several professions. In the two previous numbers of *Science Progress*, a survey of the value of scientific work to the world has been attempted. It is probably of greater advantage to the world than any other line of effort. Science has become our premier industry, and governs every other industry just as the work of the architect governs that of the individual bricklayers. The world receives not only "fairy tales" from science, but also the most wonderful fairy gifts—a greater knowledge of the universe in which we live, a greater power over nature and over barbarism, greater precision in invention, in the treatment and prevention of disease, and in our manner of judging regarding all matters under discussion. Can it be truly said that the labors of any other professions are so valuable to mankind? Where the priest, the clinician, and the lawyer do good service to the few people surrounding them, and the soldier, sailor and politician do good service for their country, the discoverer confers benefits upon the whole world, and not for the present generation only, but for all times. We have already argued the case. Mathematics, chemistry, physics, physiology and pathology have practically built up all those great and wonderful additions which modern civilization has added to the civilization of the past, and,

with their sisters of the arts, have made a fitting palace for what ought to be a higher race. Yet the payment of the highly qualified men of the same age who were not so unwise and who are still perfecting them is less than that given to all the other professions, and, compared with the value of the work, is almost infinitely less. Indeed it would appear that the second principle enunciated above is just the opposite of the truth—that work is paid for in the inverse ratio of its value: and this is not a mere cynical gibe, but the actual truth. The greatest benefits which the world has ever received, that is, those which it has received from science, literature, art and invention, have generally been paid for not at all.

But it may now be said that the scale of payment for science is purely a question of supply and demand. That is so—and the same principle governs the case of sweated industries of all kinds. In the latter, the employer exploits the necessities of a crowded and poor population in order to have his work done at the cheapest rate. As regards science, however, the employer is the public itself, and the sweated laborer is the highest type of intellect in the country. The process by which the sweating is rendered possible is something as follows: Young graduates, fired with enthusiasm for science or with the desire of investigating some question which has occurred to them, take scholarships or poorly paid research-studentships. At first, while they are young, everything goes well with them; but after some years they find that the shoe begins to pinch. Then, unfortunately, it is too late. They have lost the time which they should have used in perfecting themselves for their proper profession, whatever that may be—in which they have already been outpaced by men who formed these sciences in the past or so high-minded as themselves. The opening which they may have taken five years previously is now closed to them; and they are compelled to spend the rest of their life under the paralyzing influences described above. This also is the actual fact; and it must evidently produce a disastrous influence, not only on the men who suffer, but also upon the great studies to which they devote themselves. The most capable graduates are already beginning to perceive the truth and to avoid the toils. The elder men, seeing that investigation leads to nothing, tend to interest themselves only in teaching, compilation of text-books, and attendance upon committees. The enthusiasm and concentration which when found together are called genius become impossible; and we look almost in vain for that high devotion to science which is the only quality she rewards with success. And the punishment does not really fall so heavily upon the worker himself—his enthusiasm for science may quite possibly compensate him for such troubles as those mentioned above. But the punishment falls upon his family; it falls upon the institution which employs him; it falls upon the nation which allows such a thing; and it falls upon science herself.

Besides the low rate of pay given, there are, in this country at least, many small abuses attached to high intellectual work. Even such funds as may be allotted are not used to the best advantage. Large portions of the income of many institutions are given to the maintenance of more or less useless pursuits—which were useful pursuits in the past, but no longer serve the world, or indeed serve it only in a negative sense. Originality and success in research do not receive their due place in selection for appointments. The best paid posts are seldom given for the best work done, but rather for qualities which are of little account—popularity, eloquence, text-book knowledge, private influence, and skill in the arts of time-service. For obvious reasons it is impossible to cite examples, but the fact remains. Of the few Britons of to-day who have done world-service, how many hold the leading public posts even in their own domain? We appear to judge men, not by the work which they have done, but by the work which we may imagine, from their appearance, that they may do if we give them an opportunity. How many of our most distinguished writers, for example, have received academic posts for teaching their own art? And how many of our most

distinguished men of science are now heads of British universities?

Many other disabilities are frequently complained of and resented by scientific workers. The whole system of filling appointments requires careful reconsideration. Some years ago an excellent article on the subject of advertising vacant appointments appeared in the *University Review*. The advertisements are often issued when the post has already been practically allotted—simply as a kind of show to prove impartiality on the part of the advertising body. The result is that numbers of candidates are tempted to put themselves to great trouble and some expense, and are kept upon the tenterhooks of doubt for months. Another abuse, still allowed for academical and hospital posts, is the necessity of canvassing for appointments—a very objectionable system which compels the unfortunate applicant to visit a number of persons with whom he is not acquainted and who often have no knowledge of his subject, and to parade his virtues before them in competition with other unfortunates who are in the same case. We heard some time ago of a distinguished mathematician who was obliged to sue humbly for a poorly-paid post before two local tradespeople—and who was not accepted. Can anything show more clearly than such a state of affairs the low position held by high work in Britain? Indeed the whole system so frequently adopted here of allowing scientific institutions, hospitals and even universities, to be governed by committees of persons of whom many have no qualifications for the work, who are often not even moderately distinguished in any line, but who find their profit in the position, is thoroughly discreditable; and recent disputes in the management of certain hospitals have illustrated the defect.

We have recently started the habit of giving our rare professorships to foreigners—not really because the foreigners are the best men for the posts, but because the institution concerned likes to obtain a reputation for magnanimity. Yet foreign nations are not so generous to us. As a matter of fact we buy, not in the cheapest market, but in the dearest one; and do so, not from motives of business, but merely out of ostentation. The same indifference to work done is often manifested in the honors given by many learned bodies. We see the academic laurel placed upon the brows of soldiers, sailors and politicians—men who have perhaps done great service in their own line, though not in the line for which such honors should be reserved. The case can of course be argued—as all bad cases can; but it is really a matter of clean taste. Academic honors are meant to promote great world-service; and it is a sign of national degeneracy when they are given for anything lower. One would think that our universities would lead the way in this respect, but it is not so. Some years ago a distinguished colonial premier refused an academic honor on these grounds, and attained great honor by doing so. Few are the struggling workers or the struggling causes which have benefited by the powers in the hands of the great learned bodies. To add grist to their own mill by subserviency to popular idols appears too often to be their chief desire; and where a great worker is honored by them, he is generally a foreigner. A still lower stage, however, has already been reached—where a learned body decorates itself!

We may now ask, what exactly does the British Empire do, as a state, for science, or indeed for any of the higher forms of intellectual effort? Parliament allots £4,000 a year to one learned society, and another £1,000 a year for publications—a magnificent endowment! It allows also occasional small grants to other institutions; and all these are doled out for the expenses of special researches. The larger grants which it gives to universities are devoted chiefly to teaching—a very small proportion ever being really available for investigation. Very little of the money goes to the workers themselves, either to increase their pay or to reward them for services rendered; and the state seems to think that if it provides their test tubes and microscopes it has done enough. In many countries the government wisely pays members of certain academies; but in Britain, not only is this not done, but the state actually exacts gratuitous

services from such members. For example, a government department wishes for expert advice on some matter—it ought to form a commission of its own and honestly pay the expert members of it. Instead of doing this the government department goes to some learned society and asks it to advise on the scientific question at issue. The society is honored by the request, and obtains the advice gratis from its own members. Thus the government gets what it requires for nothing; the learned body is overpowered with the honor rendered to it; and the unfortunate worker is the loser. Such action is very common; unpaid government committees are now becoming the rule, and even reimbursement of traveling expenses is often boggled at. We heard the other day of a man who was actually found fault with for not attending a committee of this nature for which he was not paid. In other words, the state exploits the man of science on account of his enthusiasm for his work and his patriotism. The thing might be excused if the state were to give large funds for scientific work, but as it does not do so such action is extraordinary in its meanness and impropriety.

Many similar points may be cited. The board of education expends annually an enormous sum, amounting to nearly twenty millions a year, on low-class education; but what does it do for the greatest of educators—science, literature, art, drama, exploration, discovery, invention? As was pointed out in the last issue of *Science Progress*, the patent acts do not cover those whom they should most carefully protect, namely the men upon whose investigations nearly all inventions are founded. Quite recently the House of Commons has given itself payment amounting to over a quarter of a million pounds a year. Perhaps this is quite right; but may we not ask whether a small fraction of the money, properly devoted to scientific investigation in many lines, would not be of much greater benefit to the people than are the wranglings of party politicians over questions which will never be honestly decided because they are never honestly considered? Still more recently the state has given, very wisely, £57,000 a year out of the insurance fund for medical researches. It was suggested at the committee which organized the management of this expenditure that a large prize should be available out of the fund for important discoveries; but the money actually offered has now been reduced to a maximum of £1,000. In other words, if a private medical man were to discover the means of prevention or cure of tuberculosis or cancer—which he would not be likely to do without spending years of study over the theme, and probably losing his practise in consequence of his work—his only reward would be £1,000! The discoverer will not be paid; and yet the country hopes to have discoveries achieved! And this brings us to what is really the crowning defect of the national attitude towards high effort of such kinds, namely, that it makes no attempt whatever to pay for any benefits, however great, which it receives from individuals. A successful soldier may indeed receive a handsome donation, and many politicians obtain large pensions; but the highest services in the domains of science, literature and art are not deserving of reward!

The net result may of course be foretold from these data. There is much petty science, petty literature and petty art; but the more arduous labors which require the devotion of a lifetime are becoming increasingly difficult. The man of science is now exactly in the position in which writers and inventors found themselves before the copyright and patent acts were passed. He is never the master in his own house; he is the slave to institutions which "run him" for what he is worth; and is seldom able to spend his time in the exercise of the lofty gift which nature has given him. Still worse, the most capable minds are at the outset turned away from fields in which their efforts are likely to be of the highest value to humanity.

All this really springs from the curious and stupid attitude of the public towards all forms of intellectual effort. It seems to take no interest in such effort. Politics, game-playing and picture-shows are the things which amuse it. The great worker is a mere book-

worm, or a plodder, or a crank. But the truth is that, just as individuals have duties to perform to their country, so have countries duties to perform to the civilized world. It is the duty of every nation to participate in the discovery of the laws of nature, to ascertain the cause of disease, to enhance the powers of man, and to widen the range of his vision. What does Britain do to fulfil this duty? She still has great workers, it is true; but their work springs from themselves, and not from the nation. The country does not perform the duty referred to. It has become like a tradesman who has reached great wealth by the exercise of inferior arts, but who spends it on amusements, pleasures and the ostentation of charity, without sparing a penny for higher objects. This figure may at least be reached as a rough integration of the general complex formulæ of our present condition. Behind all there is a shadow: for nations, like individuals, must remain efficient.

EFFECT ON THE PROPAGATION OF ELECTRIC WAVES OF THE TOTAL ECLIPSE OF THE SUN, AUGUST 21, 1914

The committee for radiotelegraphic investigation of the British Association for the Advancement of Science calls attention to the fact that the forthcoming total eclipse of the sun affords an exceptional and important opportunity of adding to existing knowledge of the propagation of electric waves through air in sunlight and in darkness, and across the boundaries of illuminated and unilluminated regions. The eclipse will be total along a strip extending from Greenland across Norway, Sweden, Russia and Persia to the mouths of the Indus. In Russia the duration of totality will be a little more than two minutes.

There are two main points calling for investigation during the eclipse. In the first place, the propagation of signal-bearing waves through air in the umbra and penumbra will probably obey laws different as regards absorption and refraction from those obeyed in illuminated air. In the second place, the strength, frequency and character of natural electric waves, and of atmospheric discharges, may vary. The variations may occur either because the propagation of natural waves from distant sources is facilitated or impeded by the eclipse, or, possibly, because the production of natural electric waves or atmospheric discharges is for some unknown reason affected by the eclipse.

These points have previously been investigated to only a slight extent. The observers of signals during the solar eclipse of April 17, 1912, nearly all agreed that the strength of the signals was greater during the eclipse than an hour before or after. There was only one special observation of strays during the same eclipse, when very pronounced and remarkable variations were recorded during the passage of the shadow-cone across Europe.

To investigate the propagation of signals across the umbra it will be necessary to arrange for wireless telegraph stations on either side of the central line of the eclipse to transmit signals at intervals while the umbra passes between them. This transit of the umbra occupies about two minutes. It is thus very desirable that the Scandinavian and Russian stations should transmit frequently throughout several minutes before, during and after totality. But stations other than those favored by their proximity to the central line should endeavor to keep a complete record of the variations of signals during the eclipse. Stations in Europe west of the central line and stations in the Mediterranean and in Asia Minor may find noticeable changes in the strength of signals, particularly long distance signals, between the hours of 10 A.M. and 3 P.M., Greenwich time; and it is probable that the stations of India and East Africa, and ships in the Indian Ocean, may feel the effect of the penumbra in the afternoon. On the other hand, ships in the Atlantic, and fixed stations in Eastern Canada and the United States, will probably be affected by the penumbra in the early morning. At Montreal the eclipse (partial) is at its greatest phase at 5:52 A.M. standard time. It is possible that the eclipse may have some influence even when it is invisible.

The investigation of strays is of as great

interest as that of signals. So far as is yet known, the natural electric waves reaching wireless telegraph stations in latitudes higher than 50° appear to travel mostly from the south. Thus the greatest changes produced in strays by the eclipse will probably be experienced at stations in Scandinavia and Russia, to reach which the waves must cross the path of the umbra. At the same time changes of some kind are to be expected in other districts than these, and it is therefore desirable that statistical observations of natural electric waves be made all over the world, and especially at places within an earth quadrant of southern Russia. It is also desirable that meteorological observations, including those of atmospheric ionization and potential gradient, should be at the disposal of the committee when considering the records of strays and signals.

The committee proposes to prepare and circulate special forms for the collection of statistics of signals and strays, especially within the hemisphere likely to be affected by the eclipse; they will endeavor to make provision for the transmission of special signals at times to be indicated on the forms; and they will offer for the consideration of the authorities controlling stations near the central line a simple program of work. The discussion of the observations, and the comparison with meteorological data, will be carried out by the committee; and digests of the statistics, together with the conclusions drawn from the analysis, will be published in due course.

The committee would be greatly aided in the organization of this investigation if those possessing the necessary facilities and willing to make observations during the eclipse would communicate with the honorable secretary, Dr. W. Eccles, University College, London, W. C., at the earliest possible date.

THE NAPIER TERCENTENARY CELEBRATION

JOHN NAPIER'S "Logarithmorum Canonis Mirifici Descriptio" was published in 1614; and it is proposed to celebrate the tercentenary of this great event in the history of mathematics by a congress, to be held in Edinburgh on Friday, July 24, 1914, and following days.

The celebration is being held under the auspices of the Royal Society of Edinburgh, on whose invitation a general committee has been formed, representing the Royal Society of London, the Royal Astronomical Society, the town council of Edinburgh, the faculty of actuaries, the Royal Philosophical Society of Glasgow, the universities of St. Andrews, Glasgow, Aberdeen and Edinburgh, the University College of Dundee, and many other bodies and institutions of educational importance.

Through the favor of the editor of SCIENCE, the president and council of the Royal Society of Edinburgh have now the honor of giving a general invitation to mathematicians and others interested in this coming celebration.

The celebration will be opened on the Friday with an inaugural address by Lord of Appeal Sir J. Fletcher Moulton, F.R.S., LL.D. (Edin.), followed by a reception given by the Right Honorable the lord provost, magistrates and council of the city of Edinburgh. On the Saturday and Monday the historical and present practise of computation and other developments closely connected with Napier's discoveries and inventions will be discussed. A memorial service will be held in St. Giles' Cathedral on the Sunday.

Among many who have expressed a warm interest in the celebration and who hope to take part in the congress, may be mentioned Professor Andoyer, Paris; Professor J. Bauschinger, Strassburg; Professor Hume Brown, Historiographer Royal for Scotland; Professor F. Cajori, Colorado, U. S. A.; Professor G. A. Gibson, Glasgow; Dr. J. W. L. Glaisher, Cambridge; Professor Lang, St. Andrews; Professor Macdonald, Aberdeen; Professor E. Pascal, Naples; Professor Karl Pearson, London; Professor Eugene Smith, New York; Professor Steggall, Dundee; Professor Whittaker, Edinburgh.

Merchiston Castle, the residence of Napier, has long been occupied by the well-known public school, which draws pupils from all parts of the British empire. The governors of

the school have kindly invited the members of the congress to visit the castle and grounds on the Saturday afternoon.

Relics of Napier, collected by Lord Napier and Ettrick and other representatives of the family, will also be on view; and it is intended to bring together for exhibition books of tables and forms of calculating machines, which may reasonably be regarded as natural developments of the great advance made by Napier.

Individuals, societies, universities, public libraries, etc., may become founder members on payment of a minimum subscription of £2; and each founder member will receive a copy of the memorial volume, which will contain addresses and papers read before the congress, and other material of historic and scientific value. It is important to secure as many founder members as possible, so that a volume may be brought out worthy of the memory of Napier.

Ordinary subscribers attending the celebration may receive copies of the memorial volume at a reduced price.

Subscriptions and donations should be sent to the honorary treasurer, Mr. Adam Tait, Royal Bank of Scotland, St. Andrew Square, Edinburgh.

All who are interested in this proposed celebration are respectfully invited to communicate with the general secretary of the Royal Society of Edinburgh, 22 George Street, Edinburgh, and to announce their intention of being present.

C. G. Knott,
General Secretary
Royal Society of Edinburgh

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The council met at the Cosmos Club, Washington, on Tuesday, April 21, 1914, at 5:45 P.M. In the absence of the chairman, Mr. Diller presided. Those present were: Messrs. Bowie, Cattell, Diller, Gulliver, J. A. Holmes, Howard, Humphreys, D. S. Johnson, John Johnston, Kober, Metcalf, Pickering, Shear, Trelease and Twitmeyer.

The financial report of the permanent secretary was read and, on motion, was approved and ordered printed.

Mr. Cattell submitted the report of the committee on policy.

On motion, the following resolutions recommended by the committee on policy were adopted *ad seriatim:*

1. *Resolved*, that Professor Pickering be added to the committee on policy.

2. *Resolved*, that Dr. E. W. Allen, of the office of experiment stations, U. S. Department of Agriculture, be elected secretary of Section M (Agriculture) and that he be authorized, with Professor L. H. Bailey, vice-president of the section, to nominate the sectional committee for Section M and also its representative on the council.

3. *Resolved*, that the permanent secretary be instructed to inform Dr. Robert M. Ogden that no funds can be provided for the present for the associate secretary for the south beyond necessary clerical expenses.

4. *Resolved*, that the first of the Jane M. Smith life memberships be awarded to Professor Charles Henry Peck, of Albany.

5. *Resolved*, that the entrance fee be remitted to members of the Pacific Association of Scientific Societies who join the American Association during the present year.

6. *Resolved*, that the council authorise a grant of four hundred dollars to the Pacific coast committee for the expenses of its membership committee.

7. *Resolved*, that the council authorize the Pacific coast committee to adopt the constitution for the Pacific Division and that it be suggested that the second clause of the second paragraph of Article 3, beginning with the word "except," of the constitution submitted, be omitted.

8. *Resolved*, that the council give the treasurer full power to act for the association in the Colburn will case.

9. *Resolved*, that the council authorizes the appointment of Messrs. Eliot, Minot and Pickering as a committee to take the necessary steps to amend the charter of the association increasing the amount of property which may be held by the association.

10. *Resolved*, that the clerical expenses of the committee of one hundred on scientific research and its subcommittees be met from the income from the permanent funds of the association.

11. *Resolved*, that the council welcomes the action of the council of the American Chemical So-

ciety favoring the plan of holding meetings jointly with the American Association at four-year intervals.

12. *Resolved*, that the publication of the constitution and list of members be postponed until January, 1915.

On motion, it was resolved that the sectional committee of Section C be empowered to elect its vice-president and chairman for the Philadelphia meeting in consultation with the committee on policy.

L. O. HOWARD,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

DR. GEORGE WILLIAM HILL, distinguished for his contributions to mathematical astronomy, has died at the age of seventy-six years.

DR. CHARLES SANTIAGO SANDERS PEIRCE, known for his work in logic and mathematics, died on April 19, aged seventy-four years.

THE National Academy of Sciences on April 22 presented its "medals for eminence in the application of science to the public welfare," to Colonel George Washington Goethals and Brigadier General William Crawford Gorgas. The presentation was made by Dr. William H. Welch, president of the academy, at a dinner held in honor of the retiring president, Dr. Ira Remsen, and the retiring home secretary, Dr. Arnold Hague.

MEMBERS of the National Academy of Sciences were elected at the annual meeting on April 23 as follows: Ernest Merritt, physicist, Cornell University; Moses Gomberg, chemist, University of Michigan; Edward Curtis Franklin, chemist, Stanford University; Frederick Leslie Ransome, geologist, U. S. Geological Survey; Nathaniel Lord Britton, botanist, New York Botanical Garden; Henry Herbert Donaldson, neurologist, Wistar Institute of Anatomy; Herbert Spencer Jennings, zoologist, The Johns Hopkins University; Francis Gano Benedict, chemist, nutrition laboratory of the Carnegie Institution; Walter Bradford Cannon, physiologist, Harvard University; Jesse Walter Fewkes, ethnologist, Bureau of American Ethnology.

AT its annual meeting in Philadelphia on April 25, the American Philosophical Society elected to membership the following residents of the United States: Charles Greeley Abbot, Washington; James Wilson Bright, Baltimore; Bradley Moore Davis, Philadelphia; Thomas McCrae, Philadelphia; William Diller Matthew, New York; Alfred Goldsborough Mayer, Washington; Samuel Jones Meltzer, New York; John Campbell Merriam, Berkeley; Robert Andrews Millikan, Chicago; William Albert Noyes, Urbana; Stewart Paton, Princeton; Richard Mills Pearce, Philadelphia; Palmer Chamberlaine Ricketts, Troy; Harold A. Wilson, Houston; Frederick Eugene Wright, Washington. Foreign residents were elected as follows: Shibasaburo Kitasato, Tokyo; Heike Kamerlingh Onnes, Leyden; Vito Volterra, Rome.

PROFESSOR MOSES GOMBERG, of the University of Michigan, has been given the gold medal of the New York section of the American Chemical Society for his work on the trivalence of carbon.

PRINCE GALITZIN will preside over the fifth meeting of the International Seismological Association, to be held in St. Petersburg in September.

DR. J. D. FALCONER, lecturer in geography in the University of Glasgow, has been appointed by the trustees of the British Museum to the Swiney lectureship in geology, in succession to Dr. T. J. Jehu.

OLIVER BOWLES, of the department of geology and mineralogy, University of Minnesota, has been appointed quarry technologist in the division of mineral technology, Bureau of Mines, Washington, D. C.

DURING the absence abroad of Mr. William H. Fox, director of the museums of the Brooklyn Institute of Arts and Sciences, Mr. Robert Cushman Murphy, curator of mammals, is acting director.

THE German geographer, Dr. Ewald Banse, has started on an expedition for the exploration of the Libyan desert.

B. M. PATTEN, Ph.D., has received an appointment from the United States Fisheries

Department to go on the *Seneca*, a government patrol vessel, and make a study of the temperature, salinity and other qualities of the water of the ocean at various depths.

Drs. S. Marks White and Jennings C. Litzenberg, of the medical faculty at the University of Minnesota, are absent on leave the current semester. Dr. Frederick H. Scott, of the department of physiology, has been granted leave for the first semester of 1914–1915, and Professor Harold E. Robertson, of the department of pathology, has been granted a year's leave of absence during 1914–1915.

Professor B. Shimek, of the department of botany of the State University of Iowa, will carry on research work in Europe during the remainder of the year. He has been invited to deliver a series of twelve lectures, chiefly on the subjects of the plant ecology of the American desert and prairie, and the loess, at the University of Prague during the summer semester, 1914. He will also present two papers, by request, before the meeting of biologists and physicians to be held at Prague from May 31 to June 3.

Professor A. N. Winchell, of the University of Wisconsin, has returned from a visit to the Missouri School of Mines, the University of Kansas, the Agricultural College of Iowa and the University of Illinois. At each institution he delivered two lectures, one upon the "Mining Geology of the Butte District," and the other upon the "Origin of the Butte Ore Deposit."

The Syracuse Chapter of Sigma Xi has held two open meetings during the past winter. At the first, on February 20, Professor M. I. Pupin, of Columbia University, gave an address upon the topic, "Wave Conductors," with especial reference to the so-called Pupin conductors which have made present-day long-distance telephony possible. At the second open meeting, March 6, Dr. Robert Almer Harper, professor of botany at Columbia University, gave an address upon the topic, "Studies in Morphogenesis." A large audience consisting of both university and city people, greeted each lecturer.

Professor E. Heyn, of Berlin, is this year to deliver the annual May lectures before the Institute of Metals, London, upon the subject, "Internal Strains in Cold Wrought Metals."

The Friday evening meetings of the Royal Institution were resumed on April 24 when Dr. F. W. Dyson, the astronomer royal, lectured on the stars around the north pole. On May 8, Professor Karl Pearson will give an address on albinism in men and dogs; and on May 15 Professor Keeble will speak on "Plant Animals: A Study in Symbiosis."

The department of anatomy at the University of Minnesota has issued two volumes of reprints of anatomical literature, by the following members of the department: J. B. Johnston, R. E. Scammon, W. F. Allen, W. A. Hilton, E. T. Bell, T. G. Lee, W. S. Nickerson, Robert Retzgar. Volume I. covers 1909–11 and Volume II., 1912–13.

The University of Michigan has begun the publication of scientific papers of the museum of zoology, under the general title "Occasional Papers of the Museum of Zoology, University of Michigan." The papers are to be published separately, at irregular intervals, and will be numbered consecutively. The whole series will be sent through the university library to libraries and scientific institutions of a zoological nature, and the museum will distribute copies of each number to students interested in the subjects discussed.

The twenty-third session of the Marine Biological Laboratory, of Stanford University, will begin on Monday, May 25. The regular course of instruction will continue six weeks, closing July 4. Investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory will be under the general supervision of Professor G. C. Price, instructor in charge. The laboratory provides for three classes of students: (1) Teachers and students who have not had the advantages of laboratory courses in zoology. (2) Advanced students in zoology and physiology who wish to continue their studies. (3)

investigators who are prepared to carry on researches in morphology or physiology.

A SERIES of water-color plant studies painted by the late traveler and artist, Miss Adelia Gates, and presented to the Smithsonian Institution by her niece, Miss Eleanor Lewis, of Yellow Springs, Ohio, is now exhibited in the new building of the U. S. National Museum. The subjects treated embrace a wide range of foreign and domestic plants painted by the artist in this country and abroad. Some additions have recently been made to the original deposit by the donor who has endeavored to bring together all the flower studies made by Miss Gates, many of which were widely distributed by her prior to her death. With these additions, the collection now numbers some 600 paintings.

WE learn from *Nature* that a collection of rock specimens of considerable historic interest has been presented to the department of minerals of the British Natural History Museum. The specimens in question were collected in Arctic North America by Sir John Richardson, who accompanied Sir John Franklin's Arctic expeditions of 1819–1827. They have since that time been kept in the museum of the Royal Naval Hospital at Haslar, but inasmuch as the fossils collected in the same Arctic expeditions are in the National Museum at South Kensington, it was felt to be in the fitness of things that the rocks should be also preserved there. An application was accordingly made to the Lords of the Admiralty to sanction the transfer of the specimens.

FROM June 23 to 30 there will be held in London, as we learn from the London *Times*, the third annual International Congress on Tropical Agriculture, promoted by l'Association Scientifique Internationale d'Agronomie Coloniale et Tropicale. This society was formed with the idea of helping associations formed in tropical colonies for the development of their agriculture to study in common fundamental problems connected with the successful growing of important natural tropical products, such as rubber, tea, coffee, cocoa, tobacco, cocoanut oil, cotton, jute, sisal hemp and cinchona. The value of the results expected from the congress may be gauged by the fact that on the organizing committee practically every tropical colony in the British Empire is represented by its principal agricultural officer. Official notifications are being sent out by the British Foreign Office and the Ministère des Affaires Etrangères in Paris to the governments of all countries possessing tropical colonies inviting them to appoint official delegates. The congress is to meet at the Imperial Institute, South Kensington, and among the subjects suggested for papers and discussion are: Technical education and research, labor organization and supply, rubber production, development of cotton-growing, fiber production, agricultural credit banks, agriculture in arid regions, tropical hygiene and preventive medicine, plant diseases and pests, and so forth. Numerous papers on these and kindred subjects have been promised by well-known experts. Professor Wynham R. Dunstan is the chairman of committee, and Dr. T. A. Henry and Mr. H. Brown, of the Imperial Institute, are the honorary secretaries.

Two models which show how the government sells its timber have just been prepared in Washington, for display at the forest products exposition, to be held in Chicago, April 30 to May 9, and in New York, May 20 to 30. These models represent an acre of western yellow pine land in a national forest of the southwest before and after logging. In the model showing the stand before the lumberman goes into it the trees range from those only a few years old to large, overmature, stagheaded individuals more than ready for the axe. In the second model the mature trees and all others larger than a certain diameter have been cut down and made into logs and cord-wood. In this, as in all government sales, the stumps are cut low to avoid unnecessary waste, logs are taken to a small diameter well up into the tree, and such material as is not fit for lumber is converted into cordwood. Together, the models show the care which the government requires of lumbermen in felling

old trees so that the young growth is not injured. The brush is piled in heaps for burning after the lumber has been removed, in order that the fire menace which foresters say usually follows lumbering may be done away with. The models are on a scale of about one inch to five feet, so that trees approximately 100 feet tall are about 20 inches high in the models. It is the intention of the forest service to have these models set forth certain points in regard to the timber sales conducted by the government. They will demonstrate, in the first place, that the timber on the national forests is for use; placards tell how it is sold to the highest bidder when it is wanted for commercial purposes, and how it may be given away to local settlers and prospectors for developing homesteads or mines. The models themselves indicate that the timber is cut in such a way as to eliminate all avoidable waste of wood and to secure a continuance of the forest crop, not only for timber production but for the protection of the soil. They further show the fundamental principles applicable to many logging operations, that the mature and overmature trees should be removed, that thrifty growing young trees should be left to produce seed and insure a reproduction of the stand, and that the young growth should be protected from damage in lumbering operations. The models are supplemented by a graphic chart, which shows by pictured piles of money and by conventional trees of graded size the increase of timber sales on the national forests from 1905 to 1913, inclusive. In 1905 the timber sold from the national forests aggregated 96,000,000 board feet, which brought the government no more than $85,000. Three years later the amount of timber sold increased to nearly 390,000,000 board feet, and the money received rose to $735,000. In 1911 830,000,000 board feet sold for more than $2,000,000, and in 1913 more than 2,000,000,000 feet brought in contracts amounting to $4,500,000. Not all this money was received in any one year, because national forest timber is sold on contracts which range from one to twenty-five years, and it is paid for as cut.

UNIVERSITY AND EDUCATIONAL NEWS

The Catholic University of America, Washington, will receive the greater part of the estate of $1,000,000 left by Theodore B. Basselin, of Croghan.

Mr. James Deering, in a letter addressed to the trustees of Northwestern University and of Wesley Hospital, announces a gift of $1,000,000 to the hospital. It is provided that Wesley Hospital shall be a teaching hospital under Northwestern University. The gift is made in honor of the donor's father, the late William Deering, and his sister, Abbie Deering Howe, who died in 1906.

An anonymous benefactor has given a sum of $1,200,000 to the municipality of Berlin for the foundation of an open-air school for boys. In the course of instruction special attention will be given to modern languages and natural science.

Arthur Taber Jones, Ph.D., has been appointed assistant professor of physics at Smith College.

Henry Laurens, Ph.D., has been appointed instructor in biology, and George A. Stetson, instructor in mechanical engineering at Yale University.

At Harvard University, Dr. W. E. Hocking, professor of philosophy at Yale University, has been appointed professor of philosophy, and Dr. R. F. A. Hoernle, of the University of Durham, assistant professor of philosophy. Dr. E. M. East has been promoted to be professor of experimental plant morphology and H. J. Hughes, to be professor of civil engineering. Dr. S. B. Wolbach has been promoted to be associate professor of bacteriology and Dr. C. L. Bouton to be associate professor of mathematics.

The executive committee of the Massachusetts Institute of Technology has made the following promotions in the instructing staff: From the grade of associate professor to the grade of professor, Warren K. Lewis, in chemical engineering; George B. Haven, in machine design; Samuel C. Prescott, in industrial biology, and Charles B. Breed, in railroad engineering. The following assistant

professors have been advanced to the grade of associate professor: Carroll W. Doten, in economics; A. A. Blanchard, in inorganic chemistry; S. M. Gunn, in sanitary biology and public health; A. T. Robinson, in English; A. G. Woodman, in food analysis. The following instructors have been advanced to the grade of assistant professors in the departments indicated: Charles W. Green, in electrical engineering; Henry H. W. Keith, in naval architecture; John F. Norton, in chemistry of sanitation; Joseph W. Phelan, in inorganic chemistry; George W. Swett, in machine design, Frederick H. Lahee in geology. Assistants advanced to the grade of instructors are: Ralph G. Adams, in mechanical engineering; Arthur E. Bellis and Charles L. Burdick in theoretical chemistry; Edward A. Ingham in biology; Norman Osann in electrical engineering, and DeWitt M. Taylor, in mechanical engineering.

DISCUSSION AND CORRESPONDENCE

INTERPRETATIONS OF THE ANOMALIES OF GRAVITY

UNDER this title Mr. G. K. Gilbert discusses[1] the investigations of Messrs. Hayford and Bowie[2] (of the Coast and Geodetic Survey) relating to terrestrial gravity, and its application to observed earth movements by J. W. Spencer.[3] Any consideration of such important new problems should be welcomed as they tend to confirm previous results, or show their weakness or the lack of information.

Hayford and Bowie have stated that, for the purpose of making computations, the earth's crust is assumed to be in a state of perfect isostacy. They show, contrary to Gilbert's ideas on the subject, that while this is true for the whole area of the United States, there are large areas where the anomalies depart slightly from the perfect balance and smaller areas where the anomalies are considerable. This last is the special feature of Spencer's application of the anomalies of gravity to earth movements. Thus, at Washington, the excess of gravity is equal to 1,200 feet, while the deficiency at Virginia Beach (160 miles distant) is equivalent to a thickness of 1,600 feet of rock.

Hayford and Bowie have found that the topography is all compensated within a depth of 122.2 kilometers below sea-level (although they used 113.7 km. in their gravity computations); that is, the condition of stress at and below the depth of compensation is isostatic, or in other words "any element of the mass is subject to equal pressures from all directions as if it were a perfect fluid." Gilbert has misconstrued their conception of this, for he states "immobility at all depths below that of compensation is either explicitly or implicitly assumed by Hayford and Bowie." He also appears to take the view that even very small areas are completely compensated, and that much of the compensation in the vicinity of the stations, with decided or large anomalies, is located in the nucleus. This view is untenable as shown by such anomalies as those of Washington and Virginia Beach, or still greater ones between Olympia and Seattle. This compensation, located in the nucleus, presupposes very high rigidity, which is contrary to the idea of complete local isostacy, which on the other hand presupposes great plasticity.

Gilbert discusses the causes of the anomalies, favoring the one based upon the local variation of density of the column and heterogeneity of the nucleus with a sub-crustal mobile layer, which accounts for the isostacy. But all materials of the earth's crust are mobile under long-continued stress differences, yet there is sufficient rigidity in the crust to sustain local anomalies.

In his discussion, Gilbert assumes that the nucleus is composed of the same materials as

[1] U. S. Geological Survey, Professional Paper 85-*C*, pp. 29–37.

[2] Hayford, J. F., and Bowie, William, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," U. S. Coast and Geodetic Survey Special Pub. No. 10, Washington, 1912; Bowie, William, "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," *id.*, Special Pub. No. 12, Washington, 1912.

[3] Spencer, J. W., "Relationship between Terrestrial Gravity and Observed Earth Movements of Eastern America," *Am. Jour. Sci.*, 4th ser., Vol. 35, pp. 561–573, 1913.

those of the crust, and that the great density of the earth (5.6) is due to "compression by pressure," in spite of the remarkable incompressibility of even water, with the interior heat acting contrariwise. The most commonly accepted view of the great weight of the nucleus of the earth is that it is composed of heavy metallic substances; for instance, astronomer Ball regards meteorites as the remains of disrupted planets such as would be liberated by the explosion of the earth.

Concerning the relationship between the anomalies of gravity and earth movements, Dr. Gilbert says:

> Spencer emphasizes the fact that there are large plus anomalies within the region once covered by the Laurentian ice and regards it as proof that the rising of the region after the removal of the ice load was not caused by the removal of the load.

Again he says:

> The fact (of plus anomalies within this area) may equally be used to discredit the hypothesis underlying his mode of interpreting anomalies.

These statements give neither the facts nor arguments upon which Spencer bases his hypothesis that the anomalies are not due to the removal of an ice load, nor how the facts discredit his hypothesis. Observing that the plus anomaly (equaling 700 feet of rock) north of the Adirondacks, and the deformation (of 650 feet) of the earth's crust as seen in the tilted beaches, closely agree, Spencer naturally concluded that there is a direct relationship between the two phenomena. Farther south in the Adirondacks, composed of dense rocks, the anomaly of gravity is reduced to 200 feet of rock. Southward from this and extending over a very great region once covered by ice the anomalies show deficiency of weight. If the deformation adjacent to the St. Lawrence River were due to the removal of the ice sheet, then the region to the south should also have been elevated to isostate equilibrium.

Supporting Spencer's conclusions, from evidence lying outside of the glaciated region, the Appalachian belt and Florida are overweighted, although much material has been removed from the mountains. On the other hand, the coastal region is found to be underloaded, although it is here that the deposition of the materials, brought down from the mountains, have accumulated. This underloading agrees with the subsidence shown by the canyons and valleys indenting the submarine border of the continent. Yet this collateral evidence is not considered by Gilbert.

The observation of all these features is of comparatively recent date, yet they have the greatest value, although they are contrary to the hypothesis that the mobility of the earth's crust is so complete that areas of considerable size can not either be loaded or unloaded, without being fully accounted for in the isostatic balance. The phenomena of earth movements and of anomalies of gravity introduces new features in the evolution of our continents, which have only begun to be investigated.

It may be added that Professor Leverett and also Mr. Taylor have just announced that they have found moraines in the lake region, in disagreement with the hypothesis that the deformation of the earth's crust is due to the removal of the ice—results in accord with relationship of the anomalies of gravity and earth movements as lately first described by the present writer.

J. W. Spencer

HEADS OF DEPARTMENTS: A COMMENTARY UPON DR. JOHNSTON'S ARTICLE

It was very wholesome reading that Doctor Johnston offered the heads of departments in his article upon University Organization, appearing in the December 26 issue of Science, p. 908. The unfortunate conditions described so truly he evidently finds existing not in any one special institution, but in many.

Any fair-minded head realizes the disadvantages under which younger members of his staff labor. Unfortunately, there are many professors who are quite content to allow their associates to remain unheard and unheeded, either because they honestly (and ignorantly) believe them lacking in wisdom or because they fear the effect of allowing them to be in the least prominent. For such, as well as for the more liberally inclined,

Doctor Johnston's frank utterances are of benefit and form an integral part of many present-day expressions which, no doubt, will result in bettering conditions in universities.

Some readers of the article referred to might perhaps have desired more detailed expression in the author's constructive paragraphs. He fails, in the estimation of the undersigned, to give in sufficient detail, suggestions for the relief of the situation in general existing between a head of department and his staff, although it is this feature which he particularly criticizes in the article referred to. In just what position, for example, should a head regard his men, with reference to their responsibilities? In how far would the Doctor make them independent of the head, that is, free to act upon their own intiative, without first obtaining the sanction of the chief, etc.?

A detail included in Doctor Johnston's broad generalizations and annually clamoring for relief is as follows: A head, in recommending a member of his staff for advancement, either in rank or salary, is almost invariably and perhaps sometimes unconsciously influenced by prejudice. The man of pleasing personality or with a possible close social connection or representing a particular phase of the work in which the head is interested is the one recommended for promotion, although others on the staff are perhaps more useful to the institution and more deserving than the party fortunate enough, for reasons above stated, to be close to the chief. What measures of relief for this condition would Doctor Johnston advise?

We know of one department where the staff, rebelling at the recommendation made by their head, drew up and submitted to their president counter resolutions recommending a fellow member other than the one favored by their chief. But for the president to give heed to such mutinous (?) expressions, when, as the Doctor shows, he is dependent upon the various heads, would be destructive to all system and discipline.

The author intimates that men of a department should be at liberty to discuss matters of their division or department freely with the dean of a college or even carry their criticisms and complaints to higher officials. Arguing by analogy, we must assume that he would have the heads do the same—namely go around their dean and lay their woes before a president or even, disregarding the latter official, go directly to the board of regents. We hardly believe that such a system or, rather, lack of system, was in the author's mind at the time he wrote the lines referred to. If so, on the principle of "What is sauce for the goose, etc.," it would appear only right that, if the dean of a college should consult the members of a department, disregarding the head, he should expect an equal disregard of professional etiquette on the part of a head.

We doubt also whether Doctor Johnston, when he states, referring to "the results of arbitrary power placed in the hands of single men without check or publicity" that "such a system always breeds dishonesty and crime," really refers to conditions in any *university;* if such is the case, he uses somewhat strong language. One might, at this point, be a bit facetious, and we are tempted to ask the Doctor what, in his opinion, the result would be if this arbitrary power were placed in the hands of married men?

Without, in any way, taking issue with the excellent article referred to, it suggests certain phases of the problem which Doctor Johnston did not discuss and which we mention here at the risk of being regarded presuming—believing that the subject is one which merits free expression from all standpoints.

This thought occurs to the writer. The head of a department is generally several years the senior of his men and with that seniority *should* go a maturity of judgment born of an experience generally lacking in the younger men. Further, allowing that all the undesirable traits listed by Doctor Johnston may exist in a head, are we not liable to find just as many or more undesirable characteristics in the numerous young minds under him with the additional factor that the younger minds of the staff have not reached that point in development where they can see the futility of such characteristics?

Again (and here is a weakness in some heads, fortunately of rare occurrence, which Doctor Johnston fails to take cognizance of), we sometimes see the head of a department seeking to climb into favor with a dean, president or board of trustees at the expense of another department or other departments, by depreciating the work of others, by ridiculing or criticizing suggestions not emanating from his own department, by intimations and even fabrications regarding the efficiency of an associated department, etc. Fortunately, this characteristic on the part of a head is rare, although the fact that it does exist in institutions is apparent to almost any worker who has been connected with universities for twenty years or more.

Now, then, admitting that this weakness exists in some heads and realizing that characteristics of this kind are found more or less in many men, must we not admit the possibility of the same existing in the minds and characters of one, two or several of the men under a head? Do we not see young men in the profession, desiring prominence and advancement in a department, impatient, selfishly critical of their chief, undermining his position when possible, with the hope of personal advancement and so jealous of their associates of equal rank as to resort to ridicule or fabrication at their expense, if it appears to them necessary for their personal ambition? This view, of course, is an extreme one—purposely so—that we may in taking to heart Doctor Johnston's excellent remarks, not fail to see the other side of the question.

We know young men to-day—men of pronounced mentality—hypercritical of their chief and insistent upon the merits of their own views of administration—views which they might radically change after attaining maturity of experience. Some of these young men are of such self-satisfied temperament that, in years to come, if they attain positions of authority to which they aspire, they will be more dictatorial in their departments and more hide-bound in their views than the chiefs whose views they now seek to belittle.

Perhaps enough has been said to indicate to us, using, in part, a time-worn phrase, that there may be a middle course and that, in swinging from the rocks on one side of the strait, care should be taken to prevent collision with the opposite shore.

The efficiency of a department is, of course, the standard by which it is judged in the upbuilding of a university. What better basis is there than its ability to give graduate work? We know of an institution fortunate in the possession of a dean of its graduate school who, with remarkable ability in this particular line, has, by many means, not necessarily through the heads, acquainted himself with the powers in this direction, exhibited by the various departments in his institution. His records are, therefore, an index of the comparative merits and demerits of different departments and will doubtless be used for reference when occasion demands. Does this not show a tendency to get away from the autocracy of the present system?

In the writer's own department, a most happy condition, recently inaugurated, prevails. The leading members of the staff are section heads, each with his own particular line of work, his own experimental projects, his own employees, his own budget. The responsibility of expenditures and results rests directly upon the section head and he is judged accordingly. The chief of the department has a general oversight over the work of his staff and is in charge of the executive work of the division. Regular meetings of the staff, with the chief of the division as chairman, are held for the purpose of transacting business pertinent to the division, such as the approval of projects or of publications, by vote; plans for the betterment of work, courses given in college, etc., etc., and it has been found that fostering a cooperative spirit upon the part of the men and emphasizing their individual responsibility gives far better results than the opposite policy—one which is still followed (sad to relate) by department heads who have not yet "seen the light." F. L. Washburn

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SCIENTIFIC BOOKS

Gruppenweise Artbildung. By HUGO DE VRIES, Professor of Botany in Amsterdam. Berlin, 1913. Verlag von Gebrüder Borntraeger. Pp. viii + 365. Figs. 121. Colored plates 22. Price 24 marks.

Somewhat more than ten years has passed since the appearance of the first volume of "Die Mutationstheorie" and we are most fortunate to have from Professor De Vries another book that is an extension of the former discussion and that also brings forward a remarkable body of new observations of very great interest to the workers in genetics. It is not often that an investigator is able to follow an earlier work of the scope of "Die Mutationstheorie" with a book of as great import, yet we have in "Gruppenweise Artbildung" a volume that perhaps outranks the first contribution in matter and in exposition. It will surprise even the students of *Œnothera* to note the remarkably wide range of crosses among these forms that De Vries has made and the extraordinary mass of observations that he has accumulated. These are carefully indexed and readily accessible for reference.

The first part deals with the origin of species by mutation. This is a summary of the views developed in "Die Mutationstheorie" with De Vries's answers to various criticisms that have been expressed to about the year 1912. There has been no essential change in his interpretation of the "mutations" from *Œnothera Lamarckiana*, an explanation of which is offered by a somewhat more detailed statement of his theory of intracellular pangenesis. Pangens are assumed in any individual to be in an active, inactive or labile state, and mutations arise when they are in the labile condition.

As to the status of *Œnothera Lamarckiana*, De Vries stands by his original position. It is to him representative of a wild species of American origin. Papers of the reviewer concerning the identity of Lamarck's plant of 1796 and on the problem of the origin of the *Lamarckiana* of De Vries's cultures have appeared too recently to find a place in his discussion, and probably for the same reason there is no discussion of the studies of Heribert-Nilsson. De Vries takes a clear position against the view that the "mutants" of *Lamarckiana* represent the splitting of a hybrid form. He believes that hybrids between species of *Œnothera* breed true as illustrated by his reported observations on the cross between *biennis* and *muricata*. When an *Œnothera* cross gives a wide range of variants in an F_2 generation, as in the case of the hybrids between *grandiflora* and American types of *biennis*, De Vries apparently assumes that a mutating habit has descended from one or both of the parents.

Part two, treating of reciprocal and double reciprocal crosses, gives in detail the data upon which the conclusions reported by De Vries in 1911 were based. *Œnothera biennis* and *O. muricata* of Holland are two well-defined species, readily distinguishable, which breed true. Their reciprocal hybrids exhibit constant and marked differences and in the most striking of their vegetative characters strongly resemble the pollen parent. So uniform is this behavior that De Vries expresses the results with respect to the characters concerned by two formulæ—$b \times m = m$, and $m \times b = b$. The important peculiarity of these hybrids is then the fact that they differ sharply from one another to a degree very unusual in reciprocal crosses. Furthermore, the reciprocals are reported to breed true without exhibiting variation in the F_2 generation as might be expected.

These reciprocal crosses may be crossed with one another in two ways to give double reciprocals—(*biennis* × *muricata*)×(*muricata* × *biennis*), and (*muricata* × *biennis*)×(*biennis* × *muricata*). When this is done the contrasted characters of the parent type which occupies the center of the formula appear to drop out and the resulting double reciprocal hybrid presents the characters of the parent which occupies the peripheral position. Expressed in simple formulæ, which only apply to the vegetative characters under consideration—$(b \times m) \times (m \times b) = b$, and $(m \times b) \times (b \times m) = m$. The products of the double

reciprocal crosses, like the reciprocals, also breed true.

Modifications of the double reciprocal crosses, termed by De Vries sesquireciprocals, may be made by combinations of the reciprocals with the parents in such a manner that similar parent types occupy the periphery of the formulæ—$b \times (m \times b) = b$, $(b \times m) \times b = b$, $m \times (b \times m) = m$, and $(m \times b) \times m = m$. Other arrangements with the peripheral positions of the formulæ occupied by different parent types give iterative hybrids—$b \times (b \times m) = m$, $(m \times b) \times b = b$, $m \times (m \times b) = b$, and $(b \times m) \times m = m$.

The explanation of this remarkable behavior is not as yet determined. An attractive hypothesis postulates the differentiation of classes of gametes carrying the characters of the parents in pure form and their appropriate combinations either by selective fertilization or through the elimination of such gametes as do not fit into the assumed schemes of combination. But these and other speculations must await the results of cytological studies as well as further experimentation. An interesting peculiarity of these crosses is their very high degree of sterility and it remains to be seen whether the same phenomena will be found in other *Œnothera* species crosses that are more fertile. Thus it is possible that numerous and varied types of gametes may be developed by the hybrids, as theoretically would be expected, but that physiological conditions will allow only certain types to mature or function.

A long and detailed account of twin hybrids constitutes the third part. These classes of hybrids were first discovered by De Vries among hybrids of *Lamarckiana* with other species of *Œnothera*. He has since greatly extended his observations and finds twin hybrids also differentiated when certain "mutants" from *Lamarckiana* are similarly crossed (*e. g.*, *nanella*, *lata*, *scintillans*, *oblonga* and also *lævifolia*). *Brevistylis* in such crosses follows a Mendelian ratio and *gigas* gives intermediate hybrids. The twin hybrids appear in the first hybrid generation which consists of two sharply contrasted groups. In one group, termed *læta*, the characters of *Lamarckiana* are strongly dominant over those of the other parent. In the other group, termed *velutina*, the characters of the other parent dominate those of *Lamarckiana*. The proportions of the *læta* and *velutina* types appear to vary greatly in different cultures. The *velutina* types breed true in the second and later generations, but the *læta* forms were found in certain cultures to split off new lines of *velutina* in successive generations.

Another pair of twin hybrids, very different from *læta* and *velutina*, are distinguished as *densa* and *laxa*. They appear in crosses between certain broad-leaved forms of American *biennis* and *cruciata* with *Lamarckiana* or its "mutants." The distinctions here concern chiefly the form of the foliage and the number of capsules over a given length of stem; *densa* is broad-leaved with thickly crowded capsules. *laxa* has smaller leaves and capsules less numerous. The *densa* type breeds true, the *laxa* throws off in successive generations still another form, *atra*, distinguished by dark green leaves.

With the twin hybrids may be found a class of delicate and dwarfed plants, the seedlings of which are etiolated. These are named *gracilis* and they are present in very diverse proportions. Very many of the *gracilis* types die as seedlings, a few with care may be brought to maturity as narrow-leaved plants mostly sterile. The classes of dwarfs that the writer has reported for a number of crosses between *grandiflora* and American *biennis* may correspond to this group. Finally among the twin hybrids are occasionally found plants of marked size or luxuriance which appear to hold to the cultures as a whole a relation somewhat similar to that of *gigas* or *semi-gigas* to *Lamarckiana*. This type is called *hero*.

De Vries offers an explanation of twin hybrids, and of the *gracilis* and *hero* types through his theory of mutation and intracellular pangenesis. Mendelians may attempt to find in the phenomena the results of recombinations of multiple factors, although they will have difficulties in working out consistent

ratios. Others may be satisfied with an elastic view that allows of profound interactions of factors upon one another with their material modification in the "melting pot of cross breeding."

The lengthy fourth part is an examination of the chief new species of De Vries's cultures as to their behavior in crosses, with special reference to an explanation of this behavior on the theory of intracellular pangenesis. An immense amount of detail is presented, well sifted, however, by the summary and conclusions. It is interesting to note that of these new species *gigas* alone is considered as progressive; *brevistylis*, *rubrinervis* and *nanella* are regarded as retrogressive, *lata* and *scintillans* as degressive, and *oblonga* as anomalous.

Finally a fifth part on the cause of mutation gives us the latest statement of De Vries's position. This part consists of discussions of a number of topics related to other portions of the book or to earlier publications of the author, and constitutes a general summary. "Gruppenweise Artbildung" results from a gradual accumulation of mutations on the part of a species, and hybridization to De Vries includes a very much wider range of phenomena than the types interpreted by Mendelian analysis.

A comprehensive bibliography of *Œnothera* experimental literature, a full and very valuable citation of the crosses that De Vries has personally made among the Œnotheras, and an excellent index complete the volume. The 121 text-figures throughout the book are of an unusually high grade, and the 22 colored plates admirably executed. It is greatly to be hoped that the author and publisher will promptly arrange for an English translation.

BRADLEY M. DAVIS

Monographia Uredinearum seu specierum omnium ad hunc usque diem cognitarum descriptio et adumbratio systematica. By P. and H. SYDOW. Volumen III., Fasciculus I.: Pucciniaceæ, cum 7 tabulis. Lipsiæ, Fratres Borntræger. 1912. 8vo. Pp. 1–192.

The appearance of the first part of the third volume of the "Monographia Uredinearum" by P. and H. Sydow has been of especial interest to mycologists because it has given the first bit of information concerning the classification which the authors are following, or propose to follow, in this work. The two earlier volumes (Vol. I., Genus *Puccinia*, 1902–4; Vol. II., Genus *Uromyces*, 1910) were entirely taken up with the treatment of two genera, *Puccinia* and *Uromyces*, without the slightest hint as to how they were to fit into any general arrangement. It seemed evident from the beginning that these two genera were given preferences on account of their size and popular importance and not because they might appear in that order in any scheme of classification. The correctness of this surmise is now well shown. The third volume is begun with a key to the genera of the family Pucciniaceæ, a total of twenty-five being recognized. In this key *Uromyces* is number 8 and *Puccinia* number 10. In the preparation of a work of this nature there are many obvious advantages in not being hampered by the publication of a key at the start, before all of the genera are fully studied, which must thereafter serve as a guide. The freedom with which these authors began their task they have deliberately relinquished, for they are herewith publishing a key to twenty-five genera although the descriptive accounts to date only cover fully the first sixteen of them.

To do the monographic work first and follow it with a key will, however, evidently not succeed in eliminating difficulties, as is evidenced by an examination of the present part. For example, one finds that the genera *Uropyxis* and *Diorchidium* are recognized in the key as valid, although they have been treated already in previous parts as synonymous with *Puccinia*. With the exception of these four genera, which have been treated previously, the present part takes up the genera in the order of the key and proceeds as far as the generic description of *Uromycladium*, which is the sixteenth genus.

The genera in the order of their appearance are as follows, *Gymnosporangium*, *Hamasopra*,

Gymnoconia, Phragmidium, Phragmopyxis, Blastospora, Rostrupia, Triphragmium, Hapalophragmium, Sphærophragmium, Anthomyces, Uromycladium. These are distributed among the three subfamilies, Phragmidieæ, Uropyxideæ and Puccinieæ, into which the family is divided. The limitation placed on these subfamilies has not been very rigid, for the genus *Triphragmium* is included in two of them, the Phragmidieæ and the Puccinieæ. The authors, however, state that they are uncertain regarding the place which *Triphragmium, Hapalophragmium* and *Sphærophragmium* should occupy in their key. The remaining genera of the family Pucciniaceæ are *Dicheirinia, Gerwasia, Hemilea, Ravenelia, Neoravenelia, Kuehneola, Pucciniostele, Skierka,* and presumably we may expect the next part to deal with them in the order given.

The classification shows conservatism on every hand and especially in the selection of the characters upon which it is founded. The old idea of the importance of the teleutospore is maintained. Such a method can be made to work very well as long as only the common things are considered from a "practical standpoint," but when all forms are considered from a scientific standpoint it can not be said to have much in its favor. The result in the present key is uncertainty and lack of uniformity. The attempt to arrange the key in such a way as to show relationships of the genera is highly desirable, but is not attained when the boundaries for genera are so loose that species contained within them admittedly indicate relationships to different subfamilies. But the composite character of genera can not be avoided with the one character scheme as a basis for grouping. Neither can the segregation of closely related forms be prevented as long as this system is maintained. The purely artificial character of number of cells in the teleutospores will throw forms which are of undoubted relation into different genera. Numerous examples illustrative of this feature have already been cited in the literature[1] and more are constantly being found as careful comparisons are made. An arrangement which places the peach and plum rusts in the genus with *Puccinia graminis* and then separates a few forms from *Puccinia* into the genus *Rostrupia* may be "practical," but if it is any way natural it must be accidental. If *Rostrupia* which differs from *Puccinia* only in having the teleutospores with 3 or 4 cells should be maintained, it is not clear why several of the species of *Gymnosporangium* which have more than 2 cells should not be separated into a genus by themselves, or why the old genus *Phragmidium* should not be broken up into several genera, since the number of cells in the teleutospores in this group is highly variable. If the forms on Rosaceous hosts which have 2–several cells are worthy of generic standing outside of the ordinary *Puccinia* and *Rostrupia* genera, then it is not clear why the 1-celled forms on these hosts should not be separated from *Uromyces,* but such has not been done.

The bulk of the part is taken up by the genera *Gymnosporangium* and *Phragmidium,* 136 out of 192 pages being devoted to them and divided nearly equally between them. The monograph of *Gymnosporangium* is of interest in comparison with the one published by the writer about a year earlier as a Bulletin of the New York Botanical Garden.[2] The order of arrangement of the species, the plan of the keys, and the form of the descriptive accounts are the same as introduced in the writer's bulletin. Three additional species are included in the Sydow monograph, all described since the appearance of the writer's publication and founded on material not seen by him. As to the validity and relationship of the species there has not been the slightest disagreement. With one or two exceptions it is also to be noted that the specific treatment of the *Phragmidium* group is identical, so far as North American species are concerned, with Arthur's account in the Uredinales, "North American Flora." The latter, however, refers some of the species to other genera, *Earlea, Kuehneola,* while the Sydows refer all to the genus *Phragmidium.*

As regards certain nomenclatorial questions,

[1] Arthur, *Mycologia*, 4: 54–56, 1912, and Orton, *Mycologia*, 4: 194–204, 1912.

[2] Vol. 7, No. 26, 1911, pp. 391–483.

it is to be regretted that no such agreement of opinion can be recorded. When a full list of synonyms is included, as in the monograph, no great difficulty is likely to be experienced even when different authors choose to select different names as the one to be maintained, and yet instances will arise which are deplorable. The very first species in this third volume of the Sydow monograph raises some questions. They reject for it the writer's combination, *Gymnosporangium Blasdaleanum* (Diet. & Holw.) Kern, although that specific name is without question the oldest, presumably because it was founded on an æcidial stage, *Æcidium Blasdaleanum* Diet. & Holw. They also refuse to admit for this species another combination of the writer, *G. Libocedri* (P. Henn.) Kern, although this is founded on the "all important" teleutosporic stage and is the oldest specific name thus applied. Henning[3] used the combination *Phragmidium Libocedri*, cited his specimen in full, and accompanied it with an adequate description. He was in error in suggesting that *Gymnosporangium Libocedri* Mayer was the same as his plant, and we can not say that he transferred the Mayer name to *Phragmidium*, but he nevertheless very evidently did intend to apply the name *Phragmidium Libocedri* to his plant and he characterized it accordingly. To reject this specific name because he did not specially propose it *as new* seems to be a motive which is contestable and of little import. Such a procedure not only seems illogical, and is not only not followed by most botanists, but in many similar cases not by the Sydows themselves. They accept *G. Sorbi* Kern, *G. Harknessianum* Kern, *G. Photiniæ* Kern, *G. hyalinum* Kern, *G. tubulatum* Kern, *G. transformans* Kern and *G. bermudianum* Earle, although not one of these was proposed, as a new name in the genus *Gymnosporangium!* They were all transfers of æcidial names as is evidenced by the inclusion of the original authors' names in parenthesis or the words *comb. nov.* Why not say that in these instances the establishment of names has not been accomplished if one refuses to recognize æcidial names and there has been a failure to propose them in *Gymnosporangium* as new? In the case of *G. Amelanchieris* Ed. Fisch. the matter is somewhat different, for although *Amelanchieris* is a name proposed by de Candolle for the æcidial stage of the plant to which it is now applied, Fischer distinctly stated that he was not transferring de Candolle's name, but proposing another just like it as new. This appears to satisfy the conditions which it seems that the Sydows would like to impose and yet in this very instance they have given evidence that they did not regard Fischer's name as a new one but as a transfer, for their Uredineen No. 2287 was issued as *Gymnosporangium Amelanchieris* (DC.) Ed. Fisch., with *Æcidium Amelanchieris* DC. given in parenthesis as a synonym. To go back again to the first species it is to be noted that the authors after rejecting the specific names *Blasdaleanum* and *Libocedri* for it see fit to retain their own name *aurantiacum*, although there is a *Gymnosporangium aurantiacum* of Chevallier[4] published in 1826, seventy-eight years earlier.

As regards the standing of names applied to stages other than the teleutosporic, it seems evident now that these authors will accept them in cases where there is no teleutosporic name. A number of instances have already been cited in a foregoing paragraph. However, in previous parts it is not clear that they have been willing to do this; for example *Uromyces Silphii* Arth. founded on a specific name, which was originally applied to an æcidial stage, has been renamed *Uromyces Junci-tenuis* Syd. nov. nom.[5]

As already suggested, unusually full and accurate lists of synonyms have been included, but the arrangement of these is not always uniform or of such a nature as to make them most usable. It is not a straight chronological arrangement such as used by many authors, but the names are grouped according to the genera so that specific names belonging to the same genera come together. If the order of the

[3] *Hedwigia*, 37: 271–72, 1898.

[4] *Fl. Env. Paris*, 1: 424, 1826.

[5] See Sydow Monog. Ured., Vol. II., fasc. II., p. 289, 1910.

names under a genus were chronological it would facilitate matters, and while it seems to be thus in many cases, it is by no means uniformly so. Under *Gymnosporangium clavariæforme* four synonyms in the genus *Æcidium* are cited, dated as follows, 1801, 1808, 1801 and 1905; four are also given here under *Roestelia* in this order, 1849, 1887, 1880, 1815.

In the matter of illustrations the present part shows a considerable improvement over the preceding parts. The drawings of the spores show more accuracy in preparation and do not look so diagrammatical. The fact that other structures aside from the teleutospores, such as peridial cells, have had representation in these illustrations is a matter worthy of favorable comment. The printing of the plates on the regular paper makes them somewhat difficult to find. Since not all species are illustrated it is not always possible to tell from the plate and figure number in which direction from the description one should turn to find the illustration. This could be avoided by including the page number of the plate (they all have page numbers although they are not printed upon them) along with the plate and figure number where the reference is given at the end of a description. It is also very difficult to find the description of a figure if one sees an illustration and desires to look it up. Aside from the figure number there might also be given the number of the page where the description occurs. These items would increase the amount of labor in preparation, but would enhance the value of the work sufficiently to warrant it.

The authors are to be praised for the great amount of valuable work they are doing with this difficult group of fungi, and mycologists in general must be exceedingly glad that the preparation of this large monograph has proceeded so steadily. With the appearance of the present part the larger and more important genera have received treatment. The world-wide treatment of such complex plants must necessarily entail an enormous amount of labor and must necessarily involve the inclusion of forms concerning which first-hand information may be meager. These authors must be commended for the use which they make of the work of other specialists.

That they have drawn freely upon the observations of others is especially apparent in the arrangement of the keys, the form of descriptive accounts, the synonymy, and in the preparation of illustrations in this third volume. A deplorable feature is that the works of other writers and investigators may receive only slight or even no credit for the parts which are adopted by the authors or followed closely, whereas in minor portions, where there may be a difference of opinion they see fit to call attention to them in such a way as often to bring discredit upon the works which are really so largely utilized.

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The Primitive Family as an Educational Agency. By James Arthur Todd. G. P. Putnam's Sons, New York and London, 1913.

"The Primitive Family as an Educational Agency" is frankly a brief against "the family superstition" in education, a brief, let one in turn be frank enough to say, that is hardly needed by the ethnologist and that will not be heeded, I venture to predict, by the sentimentalist.

To him or her Professor Todd has undertaken to show that the past of the family is not all it is supposed to be, that monogamy, for example, is an acquired predilection, that in primitive circles kinship may be an uncertain notion and that the "natural bond" between parent and child is merely a latter day figment.

So sympathetic am I with Professor Todd's main undertaking, the cornering of the sentimentalist, and so much in agreement with his general contention that non-familial agencies may have been or may become much more efficient in education than the family that I am reluctant to criticize his method and regret having to question several of his minor arguments.

As to his method, it may be enough to merely describe it as the method of illustra-

tion, a method apt to be as satisfactory to those with you as it is unconvincing to those against you. Professor Steinmetz has pointed out for all time that haphazard instances are not ethnological proof. The soundness of the comparative method rests on the scrupulous raking through of ethnographic data. Data assembled uncritically may also be misleading. Some of Professor Todd's illustrations are misleading. In citing modern Mexicans (p. 42), for example, he is not citing, as the text would convey, a primitive people. On pp. 39 ff. he confuses the grounds of divorce with the extent of it. In referring to the *pirravru* relationship of the Australian Blackfellow (p. 35) as an affair of intermittent promiscuity he appears ignorant of the fact that it is quite as stable a relationship and as carefully regulated as the coexistent pairing relationship.

Fortunately in spite of this misconception Professor Todd has not fallen into the old promiscuity pitfall. Still he argues that in view of well verified sporadic cases of group marriage and of periodic license monogamy is not an innate instinct. To this contention it may be said that group marriage is still too obscure a fact to be called upon with much assurance in argument. Whether periodic sex license may not be more adequately explained as a phenomenon of the breaking down of habit than of the persistence of an old habit is certainly an open question. As for other deviations from monogamy, polygyny, polyandry, and prostitution, are they not due to social processes which have rendered monogamy inadequate, to considerations of social prestige or dominion, to wealth or poverty, to ancestor worship? More social processes are involved in polygamy than in monogamy.

In education through the family does the form of marriage matter at any rate quite as much as Professor Todd together with his sentimental opponents would have us think? Until very recently purposive education in or out of the family has invariably taken the form of discipline, and in the polygynous patriarchal family there has ever been a greater degree of discipline for offspring than in any monogamous type of family. Then too has not even brittleness in marriage been exaggerated as a pernicious effect upon offspring? Domestic education is essentially a matter of imitation, and one adult may be imitated as well as another. Family discord is of course pernicious, but brittleness in the marriage tie is likely to preclude discord, if anything.

But discipline is not education, I shall be told, nor is imitation. True, not in the modern meaning of the term education; but is that meaning to be reckoned with in considering any type of familial education as yet known? In all kinds of primitive education and in all kinds of familial education, primitive and modern, there has been but one purpose, the producing of conformity to type. If Professor Todd had taken this thesis as a basis for his arraignment of the rôle of the family in education, not merely pointing to it from time to time (pp. 146, 171), he would have been on safer and, I may say, more fertile ground. Moreover if he had stuck to the proposition he himself laid down at the outset that the bond between husband and wife or between parent and child is a primeval tropism based on the satisfactions resulting from safety and pleasure contacts he would have been under no necessity to show that monogamy was not an instinct, or that in view of the practise of adoption there was no natural bond in parenthood. Habitual association is the natural bond in parenthood whether adoptive or not. It is also the natural bond in marriage, whether brittle or lax. The pull of habit, whether in parentage or in marriage, Professor Todd together with many other students has overlooked.

Had he allowed for it, he would have escaped making several false generalizations. He would not have said that any sort of sex conduct was allowable among primitive men provided it did not infringe on the rights of others (p. 35)—unless of course he included among rights the right not to be discomfited by innovation, a right most jealously safeguarded by primitive man. He would not have argued that the family in which indefinite notions of kinship existed could not have exerted any great disciplinary force (p. 86).

(How about the coexistence of juridical parenthood and of discipline in the patriarchal family?) Nor would he have concluded that sex taboos, the demarcation of masculine and feminine interests, resulted in social discord (p. 54). He would have realized that sex taboos have quite the opposite effect, protecting the habits of one sex against the habits of the other. He might also have realized that age class similarly protects itself against age class and that respect for age is merely a survival of the rigid age class demarcations of primitive circles, in no sense a development (p. 131).

Until comparatively recently, "the formation of a body of habits," sex habits, age-class habits, family, clan or tribe habits was the goal of all education. As Professor Todd has well pointed out (pp. 143–4), primitive education planned to adjust youth to a static environment, to fit each boy and girl into a set place from whence no departure was possible, except into another set place. Modern education at its best plans to develop in all of us adjustability to a changing environment, together with a capacity to control our environment, *i. e.*, it plans to develop personality. To its part in this new venture of education the modern family is not yet awake. Hence its discredit in the eyes of Professor Todd and other modern educators. Once it realizes that of all educational agencies it has unique opportunities to develop personality, that far better than the school or the club it may lead a child to think for himself and to have the courage of a minority, once the family becomes alive to this new rôle—perhaps the coming "transcendent and valuable" rôle Professor Todd has in mind for it, it may assert with success its old claim to educational prestige—and not before.

Elsie Clews Parsons

NOTES ON THE SEA ELEPHANT (MIROUNGA LEONINA)

Mr. Robert Cushman Murphy has published in the *American Museum Bulletin*[1] an interesting and splendidly illustrated paper entitled "Notes on the Sea Elephant *Mirounga leonina*" (Linné). This article embodies the observations made by Mr. Murphy during a whaling and sealing voyage to the South Georgia Islands on the brig *Daisy* of New Bedford. Although sea elephants have been hunted for many years and thousands have been killed for commercial purposes, but little accurate information as to their life history is to be found in the literature of the species. This is perhaps partially due to the fact that their habitat lies on the desolate, storm-swept islands of the South Atlantic, in a region which holds out few inducements to the traveler and that almost the only visitors to their uninviting breeding grounds were those who came to slaughter the animals for commercial gain.

Too few of these hunters were interested in anything but the number of gallons of oil which could be tried out from each carcass, and ship after ship returned loaded to the gunwales with oil but empty of information concerning the habits of the greatest of all the seals which they were sweeping from off the earth. This relentless slaughter has long since passed the bounds of safety and the sea elephant bids fair to soon be numbered with the Steller's sea cow, an animal which has been swept away, leaving little but traditions behind.

Mr. Murphy's notes, taken with the care and interest of one who came to study and not to kill, are thus especially interesting, and combined with his splendid photographs form a valuable contribution to the life history of the elephant seal.

Dr. C. H. Townsend's rediscovery of the northern sea elephant (*Mirounga augustirostris*) on Guadaloupe Island, and the valuable collection of specimens and photographs which he secured, have done much to elucidate the life history of that species and Mr. Murphy has well supplemented his work by this study of the southern animal.

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[1] *Bull. Am. Mus. Nat. Hist.*, Vol. XXXIII., Art. II., pp. 63–79, pls. I.–VII.

SPECIAL ARTICLES

CARDS AS PSYCHOLOGICAL APPARATUS

"THREE thousand dollars a year for a good instructor and one dollar for paper and pins" are considered a sufficient equipment for a fair elementary psychological laboratory by at least two distinguished American psychologists. The present paper is a brief account of some of the uses that may be made of paper in one form only, playing-cards, picture post-cards and library cards as found on the market. The uses described here relate to former work, to work now being done and to further possibilities.

In general, cards commend themselves as suitable experimental material on account of their cheapness, accessibility, generality, more or less familiarity and their standard nature in shape, size, weight and quality. The standard nature of the playing cards needs no qualification, and the variations of picture post-cards in shape, form, design, etc., are easily described and their pictorial features readily reproduced when necessary.

The frictionless or slipping quality of playing cards commends them for work requiring speed; they were first used in this connection by Jastrow[1] to determine the so-called discrimination (distinction) and choice time. And as a class demonstration of the time relations of these two mental processes the cards remain perhaps as simple and as cogent as any material now in use. Seven years later Professor Bergstrom[2] used "unprinted cards with the best slipping qualities" to study the resistance or interference offered by an old habit to the acquisition of a somewhat related one. He took advantage of the diminishing states of resistance to measure the rate of forgetting a habit. And further study has shown that an established habit may not simply interfere, but that it may also favor the acquisition of a new habit, *i. e.*, an old habit may blow both *cold* and *hot*, as it were, in its effect upon a learning process, and thus a study of the potency of one learning process upon another is made possible by the use of cards. Coover and Angell[3] determined the effect that skill in tossing colored cards into six small compartments bearing colored labels has upon the rate of manipulating the typewriter. In such experimentation playing-cards have proved exceptionally useful[4] for the reason that the processes involved in their use are susceptible of analysis to the unitary stage. So that it becomes possible to make a quantitative estimate of the units of transference and interference.

The study of the "Learning Process" begun in this country by the original work of Bryan and Harter[5] on "learning telegraphic language" inspired psychologists to draft the instruments of both work and play into the service of experimentation. The hand-ball and short-hand,[6] the game of chess[7] and the typewriter[8] have each in turn made notable contributions to the learning process. But it is evident that neither these instruments nor their uses are adaptable to the laboratory as class apparatus. Economy of time alone forbids. Hand-balls are inexpensive, but ball-tossing as a learning process is narrow in its range and the operation too fantastic for laboratory purposes. There is need of simple ways and means whereby individuals of large classes may participate in the experimental operations. Among the more successful means now in use are nonsense syllables[9] and the principle of reciprocal substitution of letters, figures and conventional symbols devised by Jastrow. We would add to the list the use of playing-cards *in connection with a distribution-case.* The case and its uses require a brief description.

We have found that a case 18 inches high, 36 inches long and 4 inches deep will furnish space for 54 compartments, having six in the vertical dimension and nine in the horizontal.

[1] SCIENCE, Vol. VIII., 1886.

[2] *Amer. Jour. Psy.*, Vol. 5, 1893.

[3] *Amer. Jour. Psy.*, Vol. 18, 1907.

[4] Kline and Owens, *Psych. Rev.*, Vol. 20, 1913.

[5] *Psych. Rev.*, Vol. 4, 1897.

[6] Swift, *Amer. Jour. Psy.*, Vol. 14, 1903.

[7] Cleveland, *Amer. Jour. Psy.*, Vol. 18, 1906.

[8] Book, Wm. F., Univ. of Mont. Studies, 1908.

[9] Ebbinghaus, "Ueber das Gedachtniss," 1885.

This arrangement furnishes a compartment for each card of the pack of fifty-two, and at the same time preserves an approach to equality between the dimensions without a large excess of compartments. Each compartment is three and a half inches in length by two and three fourths inches in height, and admits completely the average playing-card when *tossed.* Each compartment is provided with a metal clip for holding detachable labels cut from the cards.

Even one unacquainted with card games and card lore will realize upon slight reflection the well-nigh endless variety of combinations made possible by their qualities of form, color and number. The case is so labeled that the opportunity for forming associations between contiguous boxes and two or more successive distributions is rare. The cards may be unstacked or stacked, according to purpose. If the latter then learning the order of the cards affords a method for the study of serial learning. The compartments receiving the cards for any series are viewed only during the process of distribution, thereby creating conditions for the study of the sense of position. Perhaps we shall make better progress in suggesting the possibilities of problems and methods by briefly submitting a problem.

Let *A* distribute the pack according to number and color, throwing to the *diamond* and *club* compartments only. This requires 26 compartments, 13 of which receive the like numbered red cards and 13 the like numbered black cards. Let *B* distribute the pack to 26 compartments throwing to the red labels according to the following plan: Throw spades to hearts, and clubs to diamonds of the same number; *e. g.*, K and Q of Clubs would go to K and Q of diamonds, respectively, while the hearts and diamonds would be distributed to their respective compartments. We say they are "resident." *A* and *B* now practise for an equal time under uniform conditions until they can distribute the pack of 52 in about 55 seconds. They, then, exchange work and although the cards are stacked the same for both series, *A* manifestly will have to learn the location of 13 heart boxes and *B* 13 club boxes; this in itself is a trifle, but it is coupled with the fact that the *directions* of the movements from box to box have made for each subject about 48, out of 52 possible, changes—a high percentage of motor interference. A further study of the consequences of the exchange of work shows that 25 per cent. of the sensory processes of the new work is identical with that of the old, while 75 per cent. is different and causes interference.[10] If now the distributing practise be continued until the former speed is attained ample opportunity is given to study the operation and fate of transferable and interferable motor and sensory processes, respectively. And of course material is furnished for two "learning curves," one for the first and one for the second series. Doubtless several other problems solvable with this material and methods will occur to the psychologist. In this connection it may be stated that it has been demonstrated that the playing cards and the case constitute a psychotechnical instrument for scientific study of certain industrial operations. This has already been demonstrated by their application to the psychological problems involved in the distribution of mail to letter cases as done by post-office and railway mail clerks.

Picture Postcards.—The value of pictures for *aussage,* memory and imaginative tests is now generally recognized together with possibilities for the study of the more intricate problems of feelings and attitudes. The technique and methods in these latter problems have not kept pace with those devised for the study of sensations and the will. The more complacent methods of introspection are to no purpose in the study of feelings and emotions since they do not come to order in the laboratory nor wait for introspective analysis; and the physiographic methods hitherto employed require considerable supplementing before the nature and relationships of the feeling consciousness are fully understood.

Some attempt has been made to use the reproductions of classic paintings in the study

10 For the basis and methods by which these quantities are determined see Kline and Owens, *Psych. Rev.*, Vol. 20, p. 224, 1913.

of feeling-tones only. And while such pictures are easily available their application is limited, for they are usually regarded by observers as pleasant or indifferent, seldom distinctly unpleasant. Their use is thus confined almost wholly in one direction, viz., that of esthetics. It is quite desirable to secure material capable of stimulating a wide range of feelings if we would make appreciable progress in their study. It appears that the advent of the picture postcards with their standard size, well-nigh endless variety and low price have more than supplied the experimental deficiencies of the classic pictures. The picture postcards make an appeal to the whole gamut of human affections. The technique for experimental purposes consists in selecting, adapting and in manipulating the cards so as to bring specific feelings into relief. To indicate uses as well as difficulties a few examples are submitted. The emotions that may be produced under laboratory conditions will always be rather feeble and so difficult to describe. The difficulty may be partially overcome by the use of picture postcards as material, some appropriate device for exposure and the law of dissociation as a method. According to James[11] the law of dissociation by varying concomitants holds for feelings as well as for sensations. The law states:

> What is associated now with one thing and now with another tends to become dissociated from either, and to grow into an object of abstract contemplation.

By alternating one picture with various others it is possible to bring to notice obscure feeling responses that would otherwise go unreported, *e. g.*, if a picture of children at play is alternated with that of a beautiful woman; it is often hard for an observer to say anything further than that the pictures seem to go well together. But if the picture of a drunkard be substituted for that of the woman, not only does the disgust at the new combination serve for an interesting study, but the former feelings can now be more readily described. We are thus furnished with a key to discover which feelings inhibit each other, which reinforce each other by contrast, and which fuse into one of a more general attitude. In short we are on the road to an analysis and synthesis of feelings.

The feelings aroused by the senses that respond to the stimuli of the outer or external world are usually objectified, *i. e.*, referred to the source of stimulation. For this reason observers are often at an utter loss to give an account of their attitude or to describe their feelings in response to a picture.[12] The psychologist's only refuge here is to call for repeated descriptions of the picture and to interpret the description in psychological terms. It is not difficult to devise conditions for readily repeating observations of the cards, and thereby enable the observer to carry the description a little farther each time. These descriptions, when carefully made, not only reveal the observers' feelings and attitudes but demonstrate the way in which apperception depends upon attitudes. These studies with the picture postcards have a practical bearing upon certain problems such as the order in which pictures should be hung in galleries, and the proper sequence and time exposure of lantern slides in illustrated lectures.

LINUS W. KLINE,
CHESTER E. KELLOGG

11 "Psychology, Briefer Course," p. 251.

12 G. Santayana, "The Sense of Beauty."

SOCIETIES AND ACADEMIES

THE ILLINOIS ACADEMY OF SCIENCE

THE seventh annual meeting of the Illinois Academy of Science was held in the engineering building of the Northwestern University, at Evanston, February 19 and 20, 1914, under the presidency of Frank W. DeWolf, director of the State Geological Survey. At the Friday session the following addresses were given:

"Recent Investigations of the Mineral Resources of the Country," by the president.

"Earth Tides," by Professor A. A. Michelson.

"The International Phytogeographical Excursion," by Professor H. C. Cowles.

"Recent Theories of Fertilization and Parthenogenesis," by Professor F. R. Lillie.

At 6:30 the members of the academy were entertained at dinner by Northwestern University. This was followed by a reception in the physical laboratory given by the local chapter of Sigma Xi.

At the Saturday meeting the following papers were presented by members of the academy:

"A Unified Science Course for High Schools," by Harold B. Shinn.

"Agricultural Science in the High Schools of Illinois," by A. W. Nolan.

"Reaction of Fishes to Temperature," by W. M. Wells.

"Soil Moisture and Plant Succession," by G. D. Fuller.

"The Vacuum Arc in Spectroscopy," by G. V. McCauley.

"Postglacial Biota of Glacial Lake Chicago," by F. C. Baker.

"Behavior Agreement Among the Animals of a Community," by V. E. Shelford.

"Evaporation and Soil Moisture in Forests and Cultivated Fields," by J. F. Groves.

"On Conditions Under Which the Vegetal Matter of the Coal Beds of Illinois Accumulated," by T. E. Savage.

"Comparative Analysis of Text-books of Zoology," by E. R. Downing.

"Recent Views Concerning Electrical Conduction in Solutions," by L. I. Shaw.

"Preliminary Note on the Cyclonic Distribution of Weather Elements for Davenport, Iowa," by A. D. Udden.

"Water Control at Evanston," by W. Lee Lewis.

At the business meeting it was decided to hold the next meeting at Springfield, February 18 and 19, 1915. The officers for the ensuing year are: *President*, Dr. A. R. Crook, Director State Museum, Springfield; *Vice-president*, Professor U. S. Grant, Northwestern University, Evanston; *Secretary*, Dr. E. N. Transeau, Eastern State Normal School, Charleston; *Treasurer*, Professor J. C. Hessler, Millikin University, Decatur.

EDGAR N. TRANSEAU,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 519th meeting was held in the assembly hall of the Cosmos Club, January 10, 1914, with President Paul Bartsch in the chair. Five new members were elected. The discussion on parallel development was continued. L. Stejneger spoke on parallelism as exhibited in reptiles, while Barton W. Evermann and Theodore Gill discussed it as related to fishes. Messrs. Eastman, Bartsch, A. D. Hopkins and William Palmer also took part in the discussion.

The 520th meeting was held January 24, 1914, with President Bartsch in the chair. Five persons were elected to membership. The program consisted of three communications:

"Winter Bird-life in the Swamps of Alabama," by E. G. Holt.

"Pollen Protection in the Flowers of *Acacia* and *Anona*," by W. E. Stafford.

"The Problem of the Gliding Gull," by William Palmer.

The 521st meeting was held February 7, 1914, President Bartsch in the chair. One new member was elected. Two communications were presented:

"Notes on the Fossil Mammals of the Fort Union," by J. W. Gidley.

"Certain Seeds Used for Ornamental Purposes in the West Indies," by J. N. Rose.

The 522d meeting was held February 21, 1914, Vice-president J. N. Rose in the chair.

The program consisted of three communications:

"Seasonal Movements of Fishes at Lake Maxinkuckee," by Barton W. Evermann.

"An American Swastika," by Henry Talbott.

"Surface Temperature in the Humboldt Current and its Coastal Eddies," by R. E. Coker.

The 523d meeting was held March 7, 1914, with Vice-president A. D. Hopkins in the chair. Three persons were elected to membership. The program consisted of two communications:

"Remains of a Prehistoric Feast," by William Palmer.

"Further Evidence of Mutation in *Œnothera*" (illustrated with lantern slides), by H. H. Bartlett.[1]

The 524th meeting was held March 21, 1914, with President Bartsch in the chair. Two new members were elected. Two communications were presented:

"Arabic Interpretations of the Songs of Birds," by Paul B. Popenoe.

"Bird Migration in the Mackenzie Valley" (illustrated with lantern slides), by Wells W. Cooke.

D. E. LANTZ,
Recording Secretary

[1] To be published in *Journal of Agricultural Research*.

SCIENCE

FRIDAY, MAY 8, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PRINCIPLES OF CURRICULUM MAKING[1]

THE favorite indoor sport of medical educators is curriculum making. As a game it ranks with jig-sawed pictures and "pigs in clover." It is not yet entirely clear whether this game should be played according to Hoyle or Marquis of Queensbury rules. The scores are published in our annual bulletins. Unfortunately no clear method of recording results has been devised. It is therefore hard to make comparisons, and no national champion has ever been declared. An expert can usually figure out the championship for any particular school. But the results would be much clearer if printed in some such form as this:

Professor Smith, Champion.... 964 hours.
Professor Jones, Runner-up... 807 hours.
Professor Brown, Booby prize. 24 hours.

It is evident that this game has interesting possibilities. Its serious discussion on this occasion may not be without value. Several of the schools of this Association have recently revised their curricula. Others are engaged just now in this work. These efforts are made necessary by a variety of conditions. In general it may be stated that dissatisfaction with the educational results obtained with existing courses of study is the principal cause of the desire for change. Furthermore, the new conditions brought about by increased entrance requirements make a readjustment of teaching desirable and perhaps imperative.

We Americans approach such a problem

[1] Presidential address at the meeting of the Association of American Medical Colleges, February 25, 1914.

with characteristic thoroughness. We are constitution makers by right of heredity. Our mechanical genius asserts itself. Our instinct is for standardization. We cut all our cogs to the same bevel. A rigid alignment of moving parts is insisted on. We are fond of link-belt machinery. We take advantage of gravity for feeding and screening. The machine runs well. The only trouble is that we forget the insignificant detail that we are making men instead of grinding corn.

A curriculum, gentlemen of the Association, is an important matter. Not so important as good individual teaching, it is true. Not so important, perhaps, as proper material equipment. Not so important as high ideals and a cooperative spirit among teachers. Nevertheless, curriculum making is a serious business. Are there no principles which may guide us in such an undertaking?

FORMER METHODS

The simplest way to form a curriculum is to have each professor state how much time he wants. This is doubtless the way the curriculum was made which every one was laughing at a few years ago and which required 230 hours of electro-therapeutics. The principle involved was "All cards have the same value. Every hand is a winner."

This method reaches its limit when the added demands of all the instructors make a larger sum of hours than the students can endure. As soon as this happened the usual procedure in the past was to place an arbitrary limit on total time requirements. Then each professor began to fight for as large a share of this time as he was able to obtain. This was probably the way in which a certain curriculum was produced containing 1,300 hours of anatomy. The principle was "Jack-high and a pistol take the pot."

These simple methods and elemental principles may have been adequate in ruder, simpler conditions. The best time-getter was often the best teacher. At least he was a strong personality. No standards existed. No state boards had formulated embarrassing exactions. The student considered one school as good as another; or, most likely, he believed the particular school he was attending to be the only good school. He was concerned with a certain square of parchment to be obtained after so many years and for the payment of so many dollars. He was not expected to think and succeeded in meeting all expectations.

THE FREE ELECTIVE SYSTEM

The opposite of these primitive methods of curriculum-making is the free elective plan. This has never been tried out in medical education. But Harvard College had a long experience with a program in which very little restriction was placed upon the students' choice of teachers and subjects. Many western universities gave equal or greater liberty to their students. It could almost be said that there was no curriculum. The principle was "American plan hotel. Everything on the table. You pay your money, and you take your choice."

The results were excellent for serious students of good judgment. But many men are not serious, and not all serious men have good judgment. A goodly proportion of men were found to be selecting their courses so as to fit in well with midnight suppers and late breakfasts and afternoon teas, or with more questionable employments. The snap course was the college man's blessing. Men were graduated whose education was an imitation veneer on a pasteboard background. As a

consequence all the colleges, I believe, have had to limit the freedom of election in a marked degree. The group system by which the student is compelled to do a considerable part of his work in one department or group of allied departments has been widely adopted. The principle is "A thorough training in a definite direction."

Of course the curriculum of a professional school is a group curriculum by the nature of things. The question is whether it shall be fixed and inflexible or variable and elastic.

GENERAL PURPOSES

Now it is evident that if we are to make any serious effort to find guidance in our own experiments in curriculum-building, we should begin by determining as well as possible what we are trying to do. It is easy to say that our first business is to make doctors—to make good doctors. But a "good doctor" is hard to know and harder still to define. I have discussed this matter before[3] and will only recapitulate my conclusions here.

A good doctor is a keen observer. We must train the powers of observation in our students. We may say that there is a technique of observing, and that we must teach this technique.

A good doctor is a trained experimenter. That is, he combines control of conditions with observation. We must train our students in experimental methods in the laboratory and at the bedside. This is technical training.

A good doctor is a skilled technician also in another and narrower sense of the word. He knows how to do certain things connected with the practise of his profession, things requiring accuracy of hand, ear and eye. He has attained a skilful adjustment of certain senso-motor reactions not provided by nor required in the ordinary experiences of life, but essential in medical practise. Such adjustment is attained only by repetition under direction; that is, by development of habit. We must train our students in the technique of their profession.

A good doctor is a man of judgment. He must be able to draw correct conclusions from observations and experiments. He must be able to synthetize isolated elemental facts into a unified compound. We express this idea when we say he must be able to think. And here is the greatest stumbling block. No one has discovered a royal road to thought. It almost seems as if it is in a man or it isn't. And yet thinking is really a kind of technique. It consists in making valuable associations. If you have on hand the proper thought-stuff and can make the right combinations of it —why, you think. Given a particular sensory stimulus, the resulting impulses presumably go bounding from part to part of the cerebral cortex instead of coming out immediately to the muscles. How these impulses travel depends on how the cerebrum is constructed and which paths have been made easy. Thought in this sense is involuntary response; it is reflex, it is habit.

A large part of our teaching is devoted to giving students what we consider valuable thought-stuff—facts, we call it. We also give them numerous examples of thinking—ready-made combinations of facts, or so-called conclusions. This is well. It ought to help them in the same way that seeing a blacksmith forge out a tool should help one to make that tool, or in the same way that seeing a surgical operation should help the student to do it. But when it comes to making new thoughts, the only

[3] *American Medical Association Bulletin*, January 15, 1911; also "Medical Research and Education," Science Press (1913), p. 375.

way is by practise and repetition and habit. We can help another man's thinking chiefly in the same way that we can help his drawing or his chemical analysis or his physical examination, by stimulating his interest, by showing him where he fails and by teaching him to criticize his own work, as he would any other technical achievement.

Finally, the good doctor is a man of character, which means again, I suspect, only that he has on hand certain kinds of brain-stuff, makes certain kinds of associations of it and reacts in certain ways to these associations. Here again example and criticism are the basis of teaching. A good doctor is skilled in the technique of right behavior. He makes mistakes in ethics no more than in counting blood corpuscles.

You will all see that I have used the word "technique" in a broad way. Probably I have stretched it too far. But for to-day we will let it stand and will ask ourselves what principles should guide us in attempting to make this kind of technicians out of the young men who come to us as students.

Putting the matter in another way, our purpose is to train scientific physicians. By a scientific physician I mean one who is imbued with the principles of science and trained in particular scientific methods. I do not mean that he should necessarily be an original investigator. I do mean that he should approach his work in the spirit of an investigator.

Our commonest stumbling block in considering a problem in curriculum making or in teaching is the unfortunate belief that we must turn out our graduates as fully trained doctors. "There is so much that they need to know," we say. This idea leads us to overcrowd the curriculum and deprive it of elasticity and virility. Our aim should be not to turn out a finished doctor, but a man who will continue to work and learn as long as he lives—a man who will consider that his student life has just begun on the day when he takes his diploma. Our aim should be not to produce a walking encyclopedia, but to inculcate the scientific spirit. What principles are likely to be of service in this work?

ENTRANCE REQUIREMENTS

Of course the first principle is that we start with good material. We depend upon certain "entrance requirements" to supply this material. We can not stop to consider these requirements to-day, except to remark their mechanical character. A sieve is a good instrument for separating different sizes of coal. It is a bad instrument for separating pebbles from diamonds. The best formulated entrance requirements will supply good material only when supplemented by personal consideration of the individual case. Often you can only tell the diamond by seeing whether it will scratch glass. My sentiment is that it is better to try out ten pebbles which will fail rather than risk throwing one diamond into the dump.

PRINCIPLE OF INDIVIDUAL DIFFERENCES

Having selected our students, we must recognize the inequality among them. No two freshmen are alike. No two seniors are alike. No two graduates are alike. No two old doctors are alike. We are all "born short" in one place, "born long" in another, to use William Hawley Smith's[3]

[3] "All the Children of All the People," Macmillan, 1912. Mr. Smith discusses also the similarities of children. Of course the principle of similarities is basic in any system of education. The trouble in medical education is that we have assumed not only similarity but even *equality* among students. This address is a protest against the prevailing rigid curricula and emphasizes therefore the differences of students, to the present disregard of their similarities. The latter

expressive metaphor. The recognition of the principle of inequality is a most important step in curriculum making. Everything else really rests upon it. If we had a magic yard-stick by which to measure each man's powers and lay out the curriculum adapted to develop those powers, it would be our duty to do so. Education would then become truly individualistic. Since we can not accomplish this ideal, we must do our best to approach it. We know that no body of men is able to lay out a perfect curriculum for medical students taken in the average or *en masse;* witness the severe criticism which may be laid against the A. M. A. model, founded though it was on two years' work by a committee of a hundred medical educators. Recognizing the principle of inequality of men, how much less can any faculty work out a fixed curriculum adapted to the student considered as an individual. To my mind the argument leads inevitably to the elastic curriculum. An elastic curriculum is not an elective curriculum, although the elective principle should find recognition in it.

PRINCIPLE OF RELATIVE VALUES

We have said that our aim is to develop technicians and that for this we must furnish facts on which the thing to be done, whether of hand or brain, is founded. In furnishing these facts, the important principle of relative values must receive emphasis. It is a fact that the stomach secretes a certain per cent. of hydrochloric acid. It is a fact that the lachrymal glands secrete a certain per cent. of sodium chloride. The former fact is much more valuable to a physician than the latter. It is valuable practically. Many other facts not immediately valuable in treating patients are valuable practically as thought-stuff. Facts are like medicines; some are for external and some for internal use. But the differences among facts as regards usefulness are as great as the differences among medicines. We should do our best from the multiplicity of facts to supply those most likely to be valuable to our students. Now the pie-maker is not a good judge of the value of pie as an article of diet, nor is the specialist in all respects in the best position to evaluate relatively his line of facts. The physiologist should have the help of the internist, the aurist, the oculist and the neurologist in determining what facts of physiology should be taught and the time to be devoted to this teaching. The principle applies equally to all the other teachers and their branches of knowledge.

PRINCIPLE OF MINIMUM REQUIREMENT

This leads to the principle of minimum requirement. Take anatomy, for example. We will all admit that certain facts of structure of the body form an indispensable part of a medical man's equipment. A knowledge of these facts must be demanded from every student. This minimum is hard to set—impossible, indeed, in a strict sense. Still, for practical purposes it must be set. In my judgment the minimum in nearly every subject is much less than schools have ordinarily required. They have required as much as possible, not as little as possible. In my opinion an effort should be made in each department to ascertain the minimum. This should be taught intensively. The merely desirable,

principle will take care of itself in any group curriculum, for as Professor Jackson has said: "Our medical students represent a selected group whose physical and mental characters are, broadly speaking, quite similar. This is tacitly assumed in making fixed requirements for the greater part of the curriculum. Yet the individual differences are undoubtedly of tremendous importance, and have hitherto been largely overlooked in medical education."

the questionable and the specialistic material should go into elective courses.

In formulating its minimum a department should bear in mind that not all the teaching of its subject-matter is done by itself. Anatomy is taught—should be and must be taught—by surgery and pathology; physiology, by medicine and pharmacology, and so on.

The sum total of these minima should constitute the required part of the curriculum. Probably they should make up between three fourths and seven eighths of the total. Nobody really knows.

PRINCIPLE OF SEQUENCE

In arranging a curriculum the principle of sequence must be kept in mind. Certain subjects are indispensable prerequisites to another subject. Others are desirable prerequisites. While this is true, it is also undoubted that this principle may be carried too far. The subject-matter of medicine is inextricably woven together. It is not even separable from the great body of general science. Our departments are in a measure artificial and arbitrary divisions. If a man goes into physiology before he has had anatomy, he is handicapped, it is true. But, on the other hand, when he gets to anatomy after physiology, he will carry to that work usable facts and enlarged interest. We may acknowledge that systematic knowledge of disease is valuable before the student can take up clinical work to best advantage, and consequently we make didactic courses prerequisite to clinics. But consider for a moment how much more intelligently the student would approach a systematic lecture course if he had previously seen some sick people. We should not allow too rigid an application of sequence to interfere with larger aims of elasticity and the recognition of individual capability and needs.

PRINCIPLE OF CONCENTRATION

In making a curriculum the principle of concentration deserves consideration. The theory is that the student does better work if he confines himself to one or a few subjects for a given short period of time. He is to concentrate on one thing and get it done. The antagonistic view is that the student gathers more from a subject kept before him for a long time. Under this theory the curriculum may include from six to a dozen subjects running through a semester or a year. Recently I met a freshman in the college of science, literature and the arts of our university who was studying seven subjects. She complained of being harried and overworked. I believe she would do better with the same number of class hours devoted to only three or four subjects. I think we should avoid the multiplicity of subjects in the junior and senior years by concentrating one hour a week lecture courses so as to run a shorter time and more periods a week. On the other hand, I can not bring myself to accept the Harvard plan by which only anatomy is studied the first semester, only physiology the second, and so on. I think Harvard has stuck to this plan more for the benefit of the teachers, who thus escape class work half of each year, than for the benefit of the students. Be that as it may, too much concentration is bad pedagogy; and in as much as it contributes to a rigid curriculum, it is a bad principle of curriculum making. A proper medium is to be sought between concentration to the crystallization point and dilution to tastelessness. At the present time we are more guilty in the latter direction, particularly as regards the rapid shifting of students among clinical instructors. If Dr. A. meets a group of students to-day and does not see them again for six weeks, how is Dr. A. to make his personal-

ity felt in these students' training? Dr. A.'s influence is lost in homeopathic dilution, which we should be ashamed to countenance.

The proper degree of concentration needed to produce best results should be possible of determination by the methods of experimental psychology. I understand that something has been accomplished in this line, particularly as regards memory. It is a common impression that "cramming" does not conduce to permanent acquisition. This conclusion is supported by laboratory tests. On the other hand, experiments prove that a subject referred to only at long intervals is not well remembered. There must be a golden mean between concentration and dilution. For this golden mean we should earnestly strive, and the psychologists should help us to find it.

PRINCIPLE OF ATTENTION AND INTEREST

Taking up more particularly the individual student in curriculum making and teaching, we should take into account the element of interest. A girl can dance all night with the pleasurable expenditure of several foot-tons of energy (no pun intended). Her back aches if she sweeps the floor, though the muscular energy discharged be insignificant. We should avoid a multiplicity of detailed laboratory exercises illustrating the same thing. The humdrum of laboratory repetition kills interest and initiative. Recognition of the principle of interest means an elastic curriculum, for the interest of one student is not the same as the interest of another student.

Interest is the basis of attention and of that self-activity which Dr. Jackson[4] so well discussed before this association two years ago. So important is this element in education that almost any sacrifice is warranted which will attain it. In our sophomore schedule at Minnesota this semester there is provision for six hours of elective work. It has been our custom in the case of conditioned or backward students to compel them to carry the required courses and postpone their electives. The other day a student appeared before the conference committee of the faculty and made a strong plea to be permitted to carry his elective. He said he was interested in that work and would rather postpone one of his regular studies. The committee voted favorably on his request; and in my opinion they acted wisely, for his failure to work with serious effort heretofore has been due to lack of interest. I expect him soon to observe that this elective work in which he is now interested is really tied up with all the rest. I expect to see his interests broaden and all of his work improve.

[4] C. M. Jackson: "On the Improvement of Medical Teaching," SCIENCE, N. S., Vol. XXXV., p. 566 (1912). Also, "Medical Research and Education," Science Press (1913), p. 367.

PRINCIPLE OF RESPONSIBILITY

Closely related is the principle of student responsibility. We are interested in work for which we are responsible. This is especially true if we select the work ourselves. A fixed curriculum deprives the student of all responsibility. He becomes a boarder coming in to meals when the bell rings, not a man laboring for his daily bread. If he may choose his subject or his instructor, his interest and responsibility increase.

Workers in the field of animal psychology tell us that animals carried through a maze never learn how to find their way alone. Let us remember this when tempted to help students over difficulties. Our teaching and our courses of study must be so planned as to encourage initiative and responsibility.

PRINCIPLE OF RESEARCH

The principle of research is very important in curriculum building. I do not advocate research with the idea that we should announce a great discovery every few minutes. I advocate it as supplying the proper atmosphere for teaching. The fixed curriculum segregates a certain portion of knowledge and teaches it as law and gospel. The student is like a red corpuscle confined by the vessel walls to a definite circuit. If the teacher has research interests, he carries them alone. His students can not follow him. The elastic curriculum permits the capable student to put out an occasional pseudopod and make little excursions with his teacher into the unknown. This can not help but react upon both student and teacher; and most important of all, on the spirit of the school. If time and opportunity for research are to be offered even to the exceptional student, it means that the electives can not be confined to the last year, as at Harvard, nor to one semester, as in some other schools. The free time should be scattered through the course, at least beginning with the sophomore year. I sometimes hear that the sophomore does not know enough to select any of his work. I can not agree. The sophomore in most of our medical schools is a junior or senior in the college of arts. He is a university man. He should be responsible. He should be thinking about what he is doing. The nursing bottle should be taken away, and he should choose and masticate his own food. Not many will nibble at research, but the aroma of it may well permeate the whole pantry. It will improve the taste of all the other food.

PRINCIPLE OF SPECIALIZATION

The principle of specialization may be given some attention. While every medical student should have the fundamental training of a general practitioner and while most of the elective courses will naturally be adapted to strengthen the student's general grasp, there is no objection, in my opinion, to a moderate extension of specialistic instruction. There are very few students who would care to move far along a specialty in their undergraduate course, and the dean or students' work committee should have power to prevent an abuse of this principle by limiting election in the specialties when such election would be likely to prejudice a student's general training.

PRINCIPLE OF UNEQUAL PROGRESS

Finally, regard for the differences and inequalities among students should make us consider their inequality of progress: the principle of unequal velocity, if you will. Some students by physical constitution and mental make-up are calculated to go forward more rapidly than others, who, being built on the "slow and careful" plan, may in the end be just as good doctors. Our arrangement of students into definite classes and a four years' required attendance is the worst possible condition for the extra bright man, whom it tempts to laziness, and for the slow man, whom it pushes beyond his powers. In my opinion students should be received at any time when a workable program can be arranged for them, and graduated at the end of any semester or summer term when they may have completed the requirements. Our extra intern year at Minnesota, as part of the requirement for the degree and consequently of attendance, will, I think, allow us to work this plan without running counter to the four-year rule of the state laws. The class system is a pernicious artificiality in education and should be done away with in professional education, if not more widely. So should the four-months' required vaca-

tion. The doctor-in-practise works eleven months or more. Why should the doctor-in-making work only eight or nine? Some students may need the long vacation for health's sake; others may need it for financial reasons. But some would be better off without the long interruption of their studies. Moreover, important elements of economy argue for the continuous session and a curriculum adapted thereto. Our expensive equipments stand idle one third of the time. Our hospitals and dispensaries go on the year around and are unused for teaching for several months. This would be poor practise in any line of business. For our northern schools, at least, the University of Chicago idea with its four quarters and its liberal curriculum, appeals to me as eminently wise. The next best thing is a strong summer term for which credit[6] is given on the regular course.

Your professors may say that they can not teach the year around. Well and good. They ought not to. While some of the older men should be "on the job" during the summer and may arrange their vacations at some other season, on the whole the summer quarter or term is a good time to give the younger men a chance. Let them conduct courses given at other times by full professors. A repetition of courses, at least in certain subjects, has advantages and is essential if a really elastic curriculum is to be developed.

CURRICULUM MAKING FROM THE SIDE OF THE TEACHER

I have gradually swung this discussion over from the side of the student to that of the teacher. Several principles of curriculum making may be formulated from the side of the faculty.

[6] The distinction between subject credit and time credit is not sufficiently recognized by medical educators. It is only time credit which is restricted by the state medical laws.

THE DEVELOPMENT OF TEACHERS

One of these principles is the development of the teacher. The rigid curriculum works but little for this cause. A professor of principles of surgery, for example, lectures year after year on that subject. For years perhaps the same manuscript is read to the classes. There is no incentive for a younger man to prepare himself. Finally, the old professor drops away, and a new and untried man must take his place. An elastic curriculum with repetition of the course under various instructors means the opportunity for the development of new men all the time. The prepared man is ready for the advanced position.

PRINCIPLE OF COMPETITION

The principle of competition is as important for efficient teaching as for any other trade or business. The rigid curriculum tends to develop a trust in teaching, with the usual bad characteristics of trusts. The elective system by giving the student a choice among several men furnishes each teacher with incentives to bring his work to the highest state of efficiency. The experience of Rush Medical College in this regard has been very instructive.

It might be thought that students would abuse this privilege of electing their instructors and that the easiest teacher would be most popular. That has not been the case. The students can be trusted to go where they get what they consider the best for themselves. Their judgment, on the whole, can be trusted. A general rule requiring approval of electives by the dean or a committee is a sufficient safeguard against the few who might search for "snap" courses.

The elective system tends to make a larger number of men available and useful as instructors and a larger number of hospitals available and usable for clinical in-

struction. So long as every student must appear before every instructor we have the tendency either unduly to reduce the number of instructors or unduly to reduce the time the individual instructor teaches. Either horn of the dilemma is dangerous. To be effective, clinical teaching must approach the ideal of individual teaching. Not how many students an instructor teaches, but how well he instructs a limited number, should be the criterion of his usefulness to a school and of his own sense of satisfaction with his work. As I have said earlier, nothing is worse than a whirlwind program which sends the students in vortices of section instruction so rapidly from teacher to teacher that no one can impress his personality upon the students. The belief that every teacher must teach every student, long since given up in colleges of arts and sciences, is pernicious and inexcusable. If your ideal of teaching is merely to reach as large a number of prospective consultants as possible, stop teaching and buy stock in a patent medicine company.

THE CURRICULUM AND THE DEPARTMENTS

As regards whole departments of instruction as distinguished from individual instructors, certain principles of curriculum making may be mentioned. A proper regard for the "born long" and "born short" demands greater elasticity in departmental procedure than is usually the case in our American schools. There should be better provision for the irregular student. Opportunities for laboratory work should be afforded at other than scheduled hours. Men should be encouraged to work alone or with a minimum of supervision. Let us limber up our laboratory organizations. Let our motto be salvation by individual work rather than salvation by formal creed. "Laboratory" should be synonymous with "Opportunity" not with "Drudgery."

The offering of electives is one important means of liberalizing a department. This system allows the instructor to vary at least a part of his work from year to year. It enables him to teach to the interested few those subjects in which he is immediately interested. It diminishes the temptation to introduce the instructor's fads as part of his required courses. It broadens the interests of a department by giving scope for all its members.

The elective system allows the young instructor who is assisting in a large required course to gain independence and confidence by conducting a small elective course in his special line. This is important.

THE CURRICULUM AND THE SCHOOL AS A WHOLE

Now as regards the school as a whole, certain principles of curriculum making may be formulated. It goes without saying that conditions as regards the quality of instructors, students and material facilities must vary among institutions. They ought not to adopt identical curricula.[6] The American Medical Association and Association of American Medical Colleges have presented models which are very valuable as points of departure. A curriculum committee should consult other schools, but not with the purpose of adopting their curricula unchanged. Each school should work out its curriculum with broad wisdom to suit its own conditions. It would be worse than folly, for example, if small and weak schools should attempt a wholesale adoption of the elective work which I so strongly

[6] While this statement is true, it may also be stated that important advantages would follow a substantial agreement among the schools as to the minimum requirements in each branch. For one thing, migration of students, at present very difficult, would be facilitated.

advocate. It would be folly even for a strong school to push this principle equally in all departments. A curriculum is a road or a race track. Road materials are quite different in central Illinois from those which abound in New England. Bear this crude analogy in mind.

The school revising its curriculum should avoid all possibility of allowing this important function to deteriorate into a contest for teaching time. Such a procedure loses sight of the principles involved and the objects to be sought. Consequently, curriculum revision must be approached with care and carried forward with tact and open-mindedness. Our recent experience at Minnesota is perhaps illuminating. The committee on revision was composed of three men only. These men studied conditions thoroughly and were able to speak with authority concerning conditions in our school and elsewhere. They studied the educational and pedagogical problems involved. This committee did not overwhelm the faculty by bringing in a complete report at one time. It first secured the approval of the faculty for certain general principles such as (*a*) "The necessity of limiting the scheduled work to about thirty hours a week or about 4,000 hours for the course." (*b*) "The necessity of clinic clerkships as a required part of the senior schedule." (*c*) "The desirability of elasticity to meet individual preparation, abilities and needs of students." The individual members of the faculty, recognizing the validity of these educational policies, approached the proposal to decrease their hours in excellent spirit. Consultations of departments with the curriculum committee led to practical unanimity of opinion on details; and when the final report was presented to the faculty, approval was quickly secured.

Gentlemen of the association, you have listened well. Probably you got into the habit when you sat upon the benches as medical students. Probably, like the students of this day, of whom we are dealing, you learned to "let it go in at one ear and out at the other." Is our lamentable ability to hear and forget due to something like interference of sound, some mental process by which the impressions from one ear annihilate those from the other? Or is it rather true that we are only to be jarred from our complacent forgetfulness, our nonchalant do-nothingness, by something unusual? I think the latter, at any rate, is a fact; and I am going to risk the dignity of the presidency and hang the moral of my previous remarks on some lines copied from the back of a seat in the amphitheater of one of our medical schools, where they had been scratched in the varnish by some medical student, departed and forgotten:

> Talk, Talk, Talk,
> Till my ears are split by the din.
> Sit, Sit, Sit,
> Till my pelvis sticks through the skin.
> In clinic and lecture and quiz
> I wear out my pants to the seam,
> Till over the benches I fall asleep
> And wear 'em out in my dream.

You laugh! But really are not these doggerel verses as pregnant with pity as the "Song of the Shirt"? Are they not as full of meaning for us as were the words of Hood for callous wealth and heedless government in poverty-stricken London?

The plaint of the student we have heard before, delivered in more dignified but less expressive form by speakers on this floor. Our students are overcrowded. They have no time to think. They do not think. Their individual qualities are crushed. They are made to conform to a common mould. The curriculum is largely responsible. We are responsible for the curriculum.

We make the usual specious arguments. The students are poorly prepared. The time of the course is too short. There is so

much to teach. Medicine is going forward so fast.

Let us broaden our conception of medical education by broadening our conception of education itself. Education is primarily the bringing out of something from within, not the forcing of something in from without. It is the discovery of the individual to himself. It is a process of training, not a process of fattening.

If these conceptions of education gain possession of us, we shall approach our teaching and our curriculum making in a corresponding spirit, and some at least of the difficulties and disappointments of our labor will disappear.

E. P. Lyon

Medical School of the University of Minnesota

INDUSTRIAL FELLOWSHIPS OF THE MELLON INSTITUTE[1]

Since January, 1912, I have made no report to this journal on the progress in the system of industrial fellowships initiated by me at the University of Kansas and since transferred to the University of Pittsburgh.

The working of these fellowships began September 1, 1911, on the university campus at Pittsburgh and in the temporary building erected at a cost of about $10,000. In March, 1913, Mr. Andrew William Mellon and Mr. Richard Beatty Mellon, brothers and citizens of Pittsburgh, impressed by the evident practical value of this system both to learning and to industry, established it on a permanent basis through the gift of over half a millon dollars and consented to allow their family name to be placed upon it as the "Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh." While working in affiliation with the university and in close sympathetic accord with it, the institute is possessed of its own funds and is under its own management.

[1] This article was written by Dr. Duncan shortly before his death.

The gift of the Messrs. Mellon has been divided for expenditure as follows:

FOR IMMEDIATE EXPENDITURE:

Permanent building	$250,000
Apparatus	60,000
Library	20,000

FOR YEARLY MAINTENANCE FOR FIVE YEARS:

$40,000 per year.

Since September, 1911, the following Fellowships have been established and in operation:

1. BAKING:*[2]

$750 a year for 2 years.

Bonus, maximum cash: $2,000.

Fellow:

Wilber A. Hobbs, B.S. (University of Kansas). (Accepted November 30, 1910.)

2. ABATEMENT OF SMOKE NUISANCE:

$12,000 1st year; $15,000 2d year; $12,000 3d year.

Fellows:

Staff in Charge

R. C. Benner, Ph.D. (University of Wisconsin), chief fellow first and second years.

J. J. O'Connor, Jr., A.B. (University of Pittsburgh), economist and chief fellow third year.

W. W. Strong, Ph.D. (Johns Hopkins), physicist.

A. F. Nesbit, B.S. (Massachusetts Institute of Technology), electrical engineer.

J. A. Beck, LL.B. (University of Pittsburgh), attorney.

E. H. McClelland, Ph.B. (Lafayette), bibliographer.

O. R. McBride, B.S. (Purdue University), engineer.

J. E. W. Wallin, Ph.D. (Yale University), psychologist.

H. H. Kimball, Ph.D. (George Washington University), meteorologist.

A. B. Bellows, B.S. (Massachusetts Institute of Technology), engineer.

J. F. Clevenger, M.S. (Ohio State University), botanist.

C. H. Marcy, bacteriologist.

Advisory Staff

Oskar Klotz, M.D., C.M. (McGill University), senior fellow.

[2] * means that the fellowship has expired.

E. W. Day, A.M., M.D. (Georgetown).
W. C. White, M.D. (Toronto).
R. T. Miller, Jr., M.D. (Johns Hopkins).
W. W. Blair, M.D. (Hahnemann).
B. A. Cohoe, A.B., M.D. (Toronto).
S. R. Haythorn, M.D. (Michigan).
W. L. Holman, M.D. (McGill).
E. B. Lee, architect, senior fellow.
Richard Hooker, B.S., architect.
C. T. Ingham, architect.
Richard Kiehnel, architect.
Carlton Strong, architect.
K. K. Stevens, B.S., architect.
(November 30, 1910; revised June 24, 1911.)

3. ON THE RELATION OF THE POTS TO GLASS IN GLASS-MAKING AND THE ELIMINATION OF "STREA":*

$1,500 a year for 2 years.
Bonus: $2,500.

Fellow:
Samuel R. Scholes, Ph.D. (Yale University).
(January 25, 1911.)

4. BAKING:*

(Wholly independent of but with acquiescence of No. 1.)

$4,750 a year for 2 years.
Bonus, cash: $10,000.

Fellows:
Henry A. Kohman, Ph.D. (University of Kansas), senior fellow.
Charles Hoffman, Ph.D. (Yale University).
Alfred E. Blake, A.B. (New Hampshire College).
(January 25, 1911.)

5. GLUE:

$1,200 a year for 2 years.

Fellow:
Ralph C. Shuey, B.S. (University of Kansas).
(February 3, 1911.)

6. SOAP:

$1,200 a year for 2 years.

Fellow:
Paul R. Parmelee, B.S. (University of Kansas).
(February 3, 1911.)

7. UTILIZATION OF FRUIT WASTE:*

$1,000 a year for 2 years.
Bonus: $10,000.

Fellow:
F. Alexander McDermott (George Washington University).
(May 12, 1911.)

8. COMPOSITION FLOORING:*

$1,500 a year for 2 years.
Bonus: 1 per cent. of sales for 5 years.

Fellow:
R. Rex Shively, B.S. (Oklahoma A. and M. College).
(August 15, 1911.)

9. CRUDE PETROLEUM:

$10,000 first year; $10,000 second year; $10,000 third year, including apparatus fund.
Bonus: Collective interest 10 per cent.

Fellows:
Benjamin T. Brooks, Ph.D. (University of Göttingen), senior fellow.
Clinton W. Clark, M.A. (Ohio State University).
Lester Pratt, M.S. (New Hampshire College).
Hugh Clark, M.A. (Ohio State University).
Arthur H. Myer, A.M. (Leland Stanford Jr. University).
Frederick Padgett, B.S. (University of Pittsburgh).
F. W. Bushong, Sc.D. (Emporia College).
I. W. Humphrey, B.S. (University of Kansas).
George W. Stratton, Ph.D. (Ohio State University).
(September 22, 1911.)

10. NATURAL GAS:

$4,000 first year; $4,000 second year; $6,000 third year, including apparatus fund.
Bonus: 5 per cent. industrial results.

Fellows:
R. H. Brownlee, Ph.D. (University of Chicago), senior fellow.
Roy H. Uhlinger, M.A. (University of Pittsburgh).
(September 22, 1911.)

11. CEMENT:*

$1,800 a year for 2 years.
Bonus: $10,000.

Fellow:
J. F. MacKey, Ph.D. (University of Toronto).
(September 22, 1911.)

12. FOODS, PROBLEMS RELATED TO THE MANUFACTURE OF:

$5,000 a year for 2 years.
Bonus: $10,000.

Fellows:

Clarence C. Vogt, Ph.D. (Ohio State University), senior fellow.

Harry P. Corliss, Ph.D. (University of Pittsburgh).

Mrs. Lou H. M. Vogt, Ph.D. (Ohio State University).

(May 20, 1912.)

13. FATS AND OILS, BLEACHING OF:

$1,500 a year for 2 years + $300 apparatus fund.

Fellow:

Leonard M. Liddle, Ph.D. (Yale University).

(May 22, 1912.)

14. EFFECT OF HIGH POTENTIAL ELECTRICITY ON CHEMICAL REACTION:

$1,000 a year for 2 years + $300 apparatus fund. Additional consideration.

Fellow:

W. E. Vawter, B.S. (University of Kansas).

(October 28, 1912.)

15. DISCOVERY OF METHODS OF COATING STEEL OR OTHER METALS WITH COPPER OR OTHER METALS:

$1,500 a year for 1 year + $500 apparatus fund; 3 months' extension.

Bonus: $10,000.

Fellow:

C. L. Perkins, B.S. (New Hampshire College).

(December 4, 1912.)

16. EXTRACTION OF COPPER FROM ITS ORES AND FROM COPPER "TAILINGS":*

$1,500 a year for 1 year.

Teaching Fellow:

Howard D. Clayton, B.A. (Ohio State University).

(December 1, 1912.)

17. DESERT PLANT AND ADDITIONAL PROBLEM:

$1,500 a year for 1 year + $300 apparatus fund.

Bonus: 7 per cent. interest industrial results.

Fellows:

R. R. Shively, Ph.D. (University of Pittsburgh).

Alfred E. Blake, M.S. (University of Pittsburgh).

(January 31, 1913.)

18. BAKING:

$6,000 a year for 2 years + $500 apparatus fund.

Bonus: $10,000.

Fellows:

Henry A. Kohman, Ph.D. (University of Kansas), senior fellow.

Charles Hoffman, Ph.D. (Yale University).

Trueman M. Godfrey, B.S. (University of Kansas).

(May 12, 1913.)

19. ALUMINUM:

$5,000 a year for 2 years, including apparatus fund.

Bonus: $10,000.

Fellows:

Hugh Clark, Ph.D. (University of Pittsburgh).

Lester A. Pratt, Ph.D. (University of Pittsburgh).

(May 12, 1913.)

20. GLUE:

$1,500 a year for 2 years + $300 apparatus fund.

Fellow:

Ralph C. Shuey, B.S. (University of Kansas).

(May 12, 1913.)

21. SOAP:

$1,500 a year for 2 years + $300 apparatus fund.

Fellow:

Ben H. Nicolet, Ph.D. (Yale University).

(May 12, 1913.)

22. GLASS:

$1,500 a year for 2 years + $300 apparatus fund.

Bonus: $3,500.

Fellow:

R. R. Shively, Ph.D. (University of Pittsburgh).

(July 14, 1913.)

23. RELATION OF ELECTRICAL POTENTIAL TO CATALYTIC ACTION:

$1,500 a year for 2 years + $300 apparatus fund.

Bonus: 5 per cent. industrial results.

Fellow:

Frank F. Rupert, Ph.D. (Massachusetts Institute of Technology).

(July 14, 1913.)

24. EXTRACTION OF COPPER FROM ITS ORES AND FROM COPPER "TAILINGS":

$1,500 a year for 1 year + $300 apparatus fund.

Fellow:

Charles O. Brown, M.A. (Cornell University).

(July 14, 1913.)

25. YEAST:

$5,200 a year for 2 years, including apparatus fund.

Bonus: $10,000.

Fellows:

F. Alex. McDermott, B.S. (University of Pittsburgh), senior fellow.

William Smith, Scholar (University of Pittsburgh).

Ruth Glasgow, M.S. (University of Illinois), bacteriologist.

James C. Cuthbert, Scholar (University of Pittsburgh).

(July 14, 1913.)

26. HARDENING OF FATS:

$1,000 a year for 1 year + $300 apparatus fund.
Bonus: 49 per cent. interest.

Fellow:

E. O. Rhodes, B.S. (University of Kansas).
(September 19, 1913.)

27. LEATHER SCRAP:

$1,000 a year for 1 year + $200 apparatus fund.
Bonus: 10 per cent. interest.

Fellow:

R. Phillips Rose, M.S. (University of Ohio).
(October 22, 1913.)

28. FERTILIZER:

$2,500 a year for 2 years, including apparatus fund.
Bonus: $5,000.

Fellow:

Earl S. Bishop, D.Sc. (Queen's University, Ontario, Canada).
(November 1, 1913.)

29. COPPER:

$6,000 a year for 1 year, including apparatus fund.

Fellows:

F. R. Weidlein, A.M. (University of Kansas), senior.

H. D. Clayton, B.S. (Ohio State University).

G. A. Bragg, B.S. (University of Kansas).
(November 6, 1913.)

30. RADIATORS:

$2,000 a year for 2 years, including apparatus fund.
Bonus: $5,000.

Fellow:

J. C. Ballantyne, B.Sc. (University College, London).
(November 18, 1913.)

31. TURBINE ENGINES:

$1,800 a year for 1 year, including apparatus fund.
Bonus: $3,000.

Fellow: (not yet appointed).
(January 5, 1914.)

32. GLASS:

$1,800 a year for 1 year, including apparatns fund.
Bonus: 25 per cent. interest.

Fellow: (not yet appointed).
(January 5, 1914.)

The total amount of money so far handed in by industrialists for expenditure in the little building mentioned above is $183,800. The total fellowship list now runs at the rate of $97,400 per year.

About the results of these fellowships, this much at this time may be stated:

1. Received a bonus of $1,000.

2. On the basis of the experimental and investigative work accomplished has been extended through a third year.

3. On the termination of this fellowship the holder went over to the company at a salary of $2,500 per year.

4. The bonus of $10,000 has been acknowledged by the company and the first installment paid. The company then asked for a second fellowship at an increased rate and with a second bonns of $10,000, which appears in this list as No. 18.

5. In recognition of the work of this fellowship the company on its expiration established a second fellowship at an increased rate, which appears in this list as No. 20.

6. On the termination of this fellowship, the fellow went over personally into his company with his process and in recognition of its success the company then established a second fellowship on the same subject at an increased rate, which appears in this list as No. 21.

7. On the conclusion of this fellowship, in lieu of the bonus, under certain conditions the proprietary rights in his process were conferred upon the fellow.

8. While this fellowship was successful, from the standpoint of the results of the investigation, it was a failure owing to changing circumstances in the specific example of the industry concerned.

9. This large and important fellowship, which had a tenure of two years, has been extended through a third year on the basis of the results accomplished. These results are of prime importance to the petroleum industry.

10. This fellowship, established for two years at $4,000 a year, has been extended through a third year for the sum of $6,000, the salary stipend of the senior fellow being raised from $2,500 a year to $4,000 a year.

11. This fellowship was a failure, owing in large measure to a lack of willingness on the part of the company concerned to cooperate with the administration and the fellow.

12. This fellowship is now in operation and it is believed that it will have a successful termination.

13. There is no question about the very success-

ful operation of this fellowship and of its ultimate results.

14. This fellowship has already yielded the essentials of an important industrial process. It has a very large importance to the institute, owing to the fact that the donor has made over all results to the institute to be used for the establishment of further researches by the institute.

15. The laboratory investigation of this subject has been completed and its large-scale working is now being arranged for. Pending the completion of the large-scale operation, the fellowship has been extended.

16. This investigation has proved so important that it has been extended through the addition of another fellowship, No. 24, at $1,500 a year, and, subsequently, of still another, No. 29, at $6,000 a year.

17. The original object of this fellowship proved impossible of an industrial solution, owing to the fact that investigation of the plant concerned showed that it contained nothing of potential industrial value. The object of the investigation was thereupon changed and the ultimate results are not yet determinable.

18. Was established by the same company on the basis of the success of No. 4. While it has been in operation only since September, it already unquestionably deserves its bonus.

19. A fellowship yielding results of prime importance.

20. Was established on the basis of the success of No. 5.

21. Was established on the basis of the success of No. 6.

22. Is already unquestionably successful.

23. A most interesting fellowship on a most interesting subject. This research is remarkable in that the donor desires that the institute should receive for its own purposes 70 per cent. of the results.

24. Established in correlation with No. 16. It is already yielding promising results.

25. A strong fellowship in operation only since September.

26. This fellowship was transferred from the University of Kansas. It has already yielded an important industrial process.

27. It is impossible to forecast the end of this fellowship.

28. Begins operation on January 5, 1914.

29. Was established in cooperation with fellowships No. 24 and No. 16. The results of this fellowship would probably justify the total expenses of the whole fellowship system.

30. Went into operation a month ago.

31. Has been accepted but is not yet signed.

32. Has been accepted but is not yet signed.

In the spring of 1912 owing to ill health, the result of too much responsibility, arrangements were made to give me an associate director, Dr. Raymond F. Bacon, who came to me from the Bureau of Chemistry at Washington. Dr. Bacon's scientific prescience, his suggestive power in research, together with his sympathetic understanding of the traditions of the work and his personal loyalty have made him an ideal associate. Since the spring of 1913, he has been aided in his work of supervision through the appointment of Dr. E. Ward Tillotson as assistant director. Dr. Tillotson has already established the success of several fellowships through his personal supervision.

The administration of the institute consists at present of the director, with the associate director and assistant director. Their work of direction and supervision is greatly lightened by the senior fellows. It should be pointed out that the fellowships of the institute consist of two kinds, individual and multiple fellowships. An individual fellowship utilizes the services of one man, directly responsible to the administration; a multiple fellowship, the intensive services of several men under the direction of a senior fellow who in turn is directly responsible and under the administration. There are seven senior fellows in the institute. The adequate supervision of the thirty-nine fellows at present in the institute is in this way entirely practicable and explains the results obtained.

The $97,400 per year at present being expended by this institute in the various researches in operation have been handed in to the institute by various companies in accordance with a definite agreement between each company concerned and the institute.

As this whole system of research is locked up in or depends upon these agreements, their importance warrants my insertion at this point of an agreement which is deemed by us at this time as representative of a reasonable arrangement. The one I submit is that of a multiple fellowship in blank.

COMPANY'S MULTIPLE FELLOWSHIP AGREEMENT

(Fellowship No. XXIX.)

This Agreement made and entered into this ——— day of ——————— 1913, between the

Mellon Institute of the University of Pittsburgh, of the City of Pittsburgh, Pennsylvania, hereinafter called the "Institute" and the ——————, of ————, —————— hereinafter called the "Company,"

WITNESSETH: that for the purpose of promoting the increase of useful knowledge, the parties hereto agree as follows:

1. The Company shall pay to the Institute annually in advance for a period of ——— years, beginning ————, 1913, the sum of ——— ——— dollars (   ) for the foundation of a Multiple Industrial Fellowship to be known as ——————————, the exclusive purpose of which is ——————————————————————————

2. The Institute shall accept the sums so to be furnished by the Company and shall devote them to the furtherance of the problems of this Fellowship; and to this end all money received from the Company under this Agreement shall be paid over by the Institute in monthly installments to the holders of this Fellowship in such amounts as may be agreed upon by the Institute and the Fellows concerned, or expended for such apparatus and supplies related to this research as the Director of the Institute may deem it advisable to purchase and for traveling expenses related to the elucidation of the problems concerned. The Fellows shall be provided, at the expense of the Institute, with a separate laboratory and with such apparatus, supplies and reagents as in the opinion of the Director constitute a reasonable provision. The Company, on its part, shall cooperate with the Institute in this research by providing the Director thereof and the Fellowe of this Fellowship with its sympathy and with whatever knowledge of the subjects of research it may possess, and, on approval of the Company, with its factory facilities for large-scale experimentation.

3. The holdere of the Fellowships provided hereunder shall be appointed by the Committee of Management of the Institute upon the nomination of the Director in accordance with the terms of their formal letters of application to and as approved by the Director, and they shall give their whole time and attention to the object of the Fellowship, with the exception, if the Director so elect, of three hours a week which each shall give to instructional work in the University of Pittsburgh. The Fellows shall work under the advice and direction of the Director and shall from time to time through the Director forward to the Company reports of the progress of their work. During the existence of the Fellowships provided hereunder the Company shall have the right, through and with the acquiescence of the Director, to employ and take into its regular service any or all of the Fellows of this Fellowship, upon terms to be agreed upon between the Fellow or Fellows and the Company, and the Institute shall appoint a successor to the Fellowship vacated by reason of the regular employment of one or more of the Fellows by the Company, provided the condition of the research work shall in the opinion of the Director make necessary or advisable the appointment of such successor.

4. The Institute, at the expiration of the Fellowship, shall return to the Company any money paid to it by the Fellow, in case any thereof shall remain unexpended for the purpose of this Fellowship.

5. Any and all discoveries made by the Fellows, or any of them, during the term of this Fellowship as well as all information obtained by them germane to the subjects of their investigation shall become the property of the Company, subject to the terms and provisions of this Agreement, and any Fellow making such discovery or obtaining such information shall promptly and without demand make revolations of all such information and discoveries. Such revelations shall be made to the duly designated representatives of the Company directly, or through the Director, as the Director may determine.

6. Any Fellow or Fellows making a discovery or invention germane to the subject of their investigation shall, at any time, at the option and expense of the Company, apply for letters patent, and shall upon demand assign such lettere patent and any and all right to such invention to the Company under the conditions of this Agreement. In case the Company desires to keep secret such discovery or invention, or for any reason desires that letters patent shall not be applied for, the Fellow or Fellows shall not at any time apply for patent or patents in their own name, and shall not disclose such discovery or invention to others except as herein provided.

7. The Company shall, in addition to the sums paid to the Institute as foundation for the Fellowships, pay to the Fellows collectively a maximum cash bonus of —————— dollars (   ) or any part thereof which in the opinion of the Board of Arbitration (hereinafter provided for) is deserved by the Fellows of this Fellowship, and the amount of this payment and the

time or times of payment shall be decided by the Board of Arbitration upon application of either of the parties hereto. The relative distribution of the bonus to the individual Fellows concerned shall be wholly within the power of the Director to decide and determine.

8. In the event of any difference of opinion between the parties hereto as to the interpretation of this Agreement, or the rights of the respective parties to this Agreement, the matters in issue shall be referred to a Board of Arbitration, which Board shall consist of a representative of the Institute and a representative of the Company, and a third person whom these two shall select. The decision of this Board shall be obtained without recourse to the courts and when rendered shall be binding upon the parties hereto.

9. During the term of this Fellowship, the holders thereof may publish such results of their investigations as do not, in the opinion of the Company, injure its interests. On or before —————, 19—, the holders thereof shall complete a comprehensive monograph on the subject of their researches. The subject matter of such monograph shall not contain specific information of the process or methods of the Company but it shall be confined to a statement of new discoveries of scientific fact obtained by this Fellowship and such statement shall not contain data or information in regard to the cost of manufacture by any process revealed in such statement. A copy of this monograph shall be forwarded to the Company and a copy shall be signed and placed in the archives of the Institute until the expiration of three years from the time hereinafter provided for the termination of this Fellowship, when the Institute shall be at liberty to publish it for the use and benefit of the public.

In the event that in the opinion of the Company such publication at such time will unduly injure its interests, it shall have the privilege of appealing at any time for an extension of time of such publication to the Board of Arbitration provided for herein, which, after considering the appeal, shall, if in its opinion such publication will unduly injure the Company's interests, extend the time of publication to a time when in the Board's opinion publication will not unduly injure the interests of the Company.

10. The Fellowships provided under this Agreement shall terminate the ——— day of ———, 191—.

In witness whereof, the parties hereto have caused their names to be subscribed the day and year first above mentioned by their duly authorized officers.

Witness: Mellon Institute of University of Pittsburgh

——————— By ———————

———————

——————— By ———————

The permanent building which will be in occupation by the institute by next September is splendidly fitted to correspond with its needs. In order that the institute may not grow too large for maximum efficiency in its different researches and for the maintenance of its fraternal spirit it has been determined to limit its members to seventy fellows. As the present number of fellows is thirty-seven, this will necessitate a considerable increase in the directional and supervisional permanent staff. Perhaps I may be permitted to say here that I am eagerly on the watch tower for men possessed of the rare qualities requisite for such positions.

The Graduate School of Specific Industries which will be connected with the Institute on the completion of its building, I shall make the subject of a future statement.

Finally it may be said, on the basis of the two years intervening since my last statement to this journal, that this system of cooperation between industry and learning, between the factory and the university, has positively passed the tentative and experimental stage and that it now stands as a valuable and permanent relation to both. Any anxieties I may have are not now connected with this example of the system, but with my desire that it should be extended into other educational institutions. We believe that this can be accomplished by handing over to the universities for this service some of our own men inducted into a full knowledge of the working of this system through years of connection with it.

Robert Kennedy Duncan

THE NEW PERUVIAN EXPEDITION UNDER THE AUSPICES OF YALE UNIVERSITY AND THE NATIONAL GEOGRAPHIC SOCIETY

LAST Saturday there sailed for Peru the topographical division of a new expedition. The chief engineer, E. C. Erdis, of the 1912 expedition, had sailed the week before. In a short time two more members of the expedition will sail, and as soon as the maps have been completed and are ready for use, the scientific members of the party will leave for the field. This will probably not be until early in 1915.

As in 1912 the expedition is under the joint auspices of Yale University and the National Geographic Society. Unlike former expeditions, it will cover a period of two years, instead of being confined to one field season. Three members of the expedition, the chief engineer, the chief assistant, and the assistant topographer, will be in the field for a year and a half, or more.

It is our plan to make a geographical reconnaissance of a portion of southern Peru, including the Cordillera Vilcabamba and portion of the Apurimac and Urubamba watersheds.

This region is a part of the eastern edge of the great Andean plateau. The Cordillera Vilcabamba is a chain of dissected mountains rising 16,000 to 20,000 feet above sea-level, situated between south latitudes 12 and 14. Their bases are clothed with tropical jungles, while their summits are mantled with snow and glaciers. In the main they are unexplored. As one of the most inaccessible parts of the Andes, they have been occupied from time to time by the ancient peoples of Peru. In this region are the ruins of Machu Picchu, Palcay and Choqquequirau.

The reported presence of other ruins and the actual existence of some that have been seen, but not studied or mapped, make the region a particularly attractive area in which to study the problem of man's origin and distribution in South America.

The character of the land formations in the neighborhood of the ruins should enable something to be said in regard to the number of people formerly occupying the region, the causes of the location of the cities, buildings and forts, and the reasons for their final abandonment.

An examination of the ruins, studies of the styles of architecture, and of the artifacts and other remains that may be found fairly near the surface of the ground, should eventually enable a classification to be made, which, in connection with biological, physiographic, linguistic and historical studies, ought to result finally in unravelling the puzzle of the ancient civilization of South America. From the standpoint of biology, this area is believed to contain a large number of species new to science. From the standpoint of anthropology it is one of the least known and most fruitful areas in the Andes.

The plan of work will include the making of a topographical map of the region northwest of Cuzco between the Apurimac and Urubamba Rivers; a detailed geographical reconnaissance of the more lofty portions of the mountains, including a study of the large undescribed glaciated region; the establishment of two meteorological stations at different elevations for the taking of systematic records for two years; a study of the distribution and history of food plants of this region; the collection of data respecting the forms and distribution of vertebrates, particularly mammals and reptiles; a survey of the present Indians inhabiting this region, including a study of their dialects, the collection of anthropometric data, and the collection and study of the skeletal remains; an archeological reconnaissance of the entire area, and a continuation of the studies begun by the first expedition, looking toward a geographical interpretation of the Spanish chronicles of the era of discovery and exploration, with particular reference to the identification of ancient place names, the story of Machu Picchu and its connection with the history of the Incas.

The staff of the expedition consists of: Ellwood C. Erdis, chief engineer; Herbert E. Gregory, geologist (Silliman professor of geology in Yale University); George F. Eaton,

osteologist (curator of osteology in the Peabody Museum of Yale University); Albert H. Hardy, chief assistant; C. F. Westerberg, assistant topographer; H. S. Arnold, M.D., medical adviser; Philip A. Means, assistant in archeology; L. M. Kirkpatrick, secretary. The surgeon has not yet been named.

HIRAM BINGHAM,
Director

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THIS committee, authorized by the council of the association and appointed at and after the Atlanta meeting by President Wilson and President Eliot with the advice of the committee of policy, met at the Cosmos Club, Washington, on the afternoon of April 20, 1914. Mr. Pickering was in the chair, and the following members were present:

Messrs. C. L. Alsberg, E. W. Brown, J. McK. Cattell, C. B. Davenport, K. E. Guthe, George E. Hale, Ross G. Harrison, L. O. Howard, C. S. Howe, William H. Howell, W. J. Humphreys, William W. Keen, C. Kenneth Mees, George A. Miller, E. L. Nichols, Arthur A. Noyes, Henry F. Osborn, E. C. Pickering, Ira Remsen, Frank Schlesinger, Elihu Thomson, O. H. Tittmann, Thomas L. Watson, Arthur G. Webster, William M. Wheeler and R. S. Woodward.

The membership of the committee was completed by election, and there was a long and important discussion on scientific research in America and the means by which it can be advanced by the committee. Among the questions fully discussed were (1) the use of research funds and the establishment of a central bureau under the auspices of the association, the National Academy or the Smithsonian Institution; (2) research work in educational institutions, the extent to which it is supported and should be regarded as the function of the institution and its professors and instructors; (3) the research work of industrial laboratories and its relation to the universities; (4) the selection of men in universities competent to undertake research work and the preparation that should be given to them, and (5) the fuller recognition and better opportunities that should be given to those who have unusual qualifications for scientific research. It was agreed that the principal work of the committee should be entrusted to subcommittees. The whole committee will meet at Philadelphia on the afternoon of Monday, December 28, 1914, at the hotel headquarters of the American Association.

Sub-committees were authorized in each of the five directions above noted. The three last-mentioned topics were emphasized, respectively, by Mr. C. Kenneth Mees, Mr. Ernest W. Brown and Mr. Theodore W. Richards, and a sub-committee on each of the subjects will be formed with their advice. The committees named are:

Executive Committee: E. C. Pickering, *Chairman*, Charles D. Walcott, William H. Welch, Edmund B. Wilson, J. McKeen Cattell, *Secretary*.

Sub-committee on Research Funds: Charles S. Minot, *Chairman*, Simon Flexner, E. C. Pickering, R. S. Woodward, Charles R. Cross, *Secretary*.

Sub-committee on Research in Educational Institutions: Edward L. Nichols, *Chairman*, Edwin G. Conklin, Arthur A. Noyes, John M. Coulter, J. McKeen Cattell, *Secretary*.

The full membership of the Committee of One Hundred is as follows:

Eliot, Charles W., president of the association, president emeritus of Harvard University, *Chairman*.

Pickering, E. C., director of the Harvard College Observatory, *Chairman of the Executive Committee*.

Adams, Frank D., professor of geology, McGill University.

Alsberg, C. L., chief of the Bureau of Chemistry, U. S. Department of Agriculture.

Ames, J. S., professor of physics, Johns Hopkins University.

Angell, J. R., professor of psychology, University of Chicago.

Baldwin, S. E., professor of law in Yale University and governor of Connecticut.

Bancroft, W. D., professor of physical chemistry, Cornell University.

Bessey, Charles E., professor of botany, University of Nebraska.

Boas, Franz, professor of anthropology, Columbia University.

Britton, N. L., director of the New York Botanical Garden.

Brown, Ernest W., professor of mathematics, Yale University.

Campbell, Douglas H., professor of botany, Stanford University.

Campbell, W. W., director of Lick Observatory.

Chamberlin, T. C., professor of geology, University of Chicago.

Chittenden, R. H., professor of physiological chemistry, Yale University.

Cole, Alfred D., professor of physics, Ohio State University.

Conklin, Edwin G., professor of zoology, Princeton University.

Cottrell, F. G., professor of physical chemistry, University of California.

Coulter, John M., professor of botany, University of Chicago.

Councilman, W. T., professor of pathology, Harvard University.

Cross, Charles R., professor of physics, Massachusetts Institute of Technology.

Davenport, C. B., director of the Station for Experimental Evolution, Carnegie Institution.

Davis, William M., emeritus professor of geology, Harvard University.

Day, Arthur L., director of the Geophysical Laboratory, Carnegie Institution.

Dewey, John, professor of philosophy, Columbia University.

Donaldson, H. H., professor of neurology, Wistar Institute of Anatomy.

Fairchild, H. L., professor of geology, Rochester University.

Farlow, W. G., professor of cryptogamic botany, Harvard University.

Fisher, Irving, professor of economics, Yale University.

Flexner, Simon, director of the laboratories, Rockefeller Institute for Medical Research.

Franklin, Edward C., professor of organic chemistry, Stanford University.

Gill, Theodore, professor of zoology, George Washington University.

Goodale, George L., emeritus professor of botany, Harvard University.

Guthe, Karl E., professor of physics, University of Michigan.

Hale, George E., director of Mount Wilson Solar Observatory, Carnegie Institution.

Harrison, Ross G., professor of comparative anatomy, Yale University.

Hayford, John F., director of the College of Engineering, Northwestern University.

Holmes, Joseph A., chief of the Bureau of Mines.

Howard, L. O., chief of the Bureau of Entomology.

Howe, Charles S., president of the Case School of Applied Science.

Howell, William H., professor of physiology, The Johns Hopkins University.

Humphreys, W. J., professor of meteorology, U. S. Weather Bureau.

Hunt, Reid, professor of pharmacology, Harvard University.

Jordan, David Starr, president of Stanford University.

Keen, William W., emeritus professor of surgery, Jefferson Medical College, president of the American Philosophical Society.

Kemp, James F., professor of geology, Columbia University.

Leuschner, Armin O., professor of astronomy, University of California.

Lillie, Frank R., professor of embryology, University of Chicago.

Loeb, Jacques, head of department of experimental biology, Rockefeller Institute for Medical Research.

MacDougal, D. T., director of the department of botanical research, Carnegie Institution.

Maclaurin, R. C., president of the Massachusetts Institute of Technology.

McMurrich, J. Playfair, professor of anatomy, University of Toronto.

Mall, Franklin P., professor of anatomy, Johns Hopkins University.

Marvin, C. F., chief of the U. S. Weather Bureau.

Mees, C., Kenneth, Eastman Kodak Company, Rochester, N. Y.

Mendenhall, T. C., president emeritus, Worcester Polytechnic Institute.

Michelson, A. A., professor of physics, University of Chicago.

Miller, G. A., professor of mathematics, University of Illinois.

Millikan, R. A., professor of physics, University of Chicago.

Minot, Charles S., professor of comparative anatomy, Harvard Medical School.

Moore, E. H., professor of mathematics, University of Chicago.

Moore, George T., director of the Missouri Botanical Garden.

Morgan, T. H., professor of experimental zoology, Columbia University.

Morley, Edward W., emeritus professor of chemistry, Western Reserve University.

Morse, Edward S., director, Peabody Academy of Science.

Moulton, Forest R., professor of astronomy, University of Chicago.

Neal, Herbert V., professor of biology, Tufts College.

Nichols, Edward L., professor of physics, Cornell University.

Noyes, Arthur A., director of the research laboratory of physical chemistry, Massachusetts Institute of Technology.

Noyes, W. A., professor of chemistry, University of Illinois.

Osborn, Henry F., president of the American Museum of Natural History, research professor of zoology, Columbia University.

Pearce, R. M., professor of research medicine, University of Pennsylvania.

Putnam, E. W., professor emeritus of anthropology, Harvard University.

Remsen, Ira, professor of chemistry, Johns Hopkins University.

Richards, Theodore W., professor of chemistry, Harvard University.

Rosa, Edward B., chief physicist, Bureau of Standards.

Schlesinger, Frank, director of the Allegheny Observatory.

Sedgwick, William T., professor of biology, Massachusetts Institute of Technology.

Smith, E. F., provost of the University of Pennsylvania.

Smith, G. Otis, director of the U. S. Geological Survey.

Smith, Hugh M., U. S. commissioner of fisheries.

Smith, Theobald, professor of comparative pathology, Harvard University.

Stieglitz, Julius, professor of analytical chemistry, University of Chicago.

Stiles, Ch. Wardell, zoologist, U. S. Public Health Service.

Stratton, Samuel W., director of the Bureau of Standards.

Thomson, Elihu, Thomson-Houston and General Electric Companies.

Titchener, Edward B., professor of psychology, Cornell University.

Tittmann, Otto H., chief of the U. S. Coast and Geodetic Survey.

Van Hise, Charles R., president of the University of Wisconsin.

Walcott, Charles D., secretary of the Smithsonian Institution.

Ward, Henry B., professor of zoology, University of Illinois.

Watson, Thomas L., professor of economic geology, University of Virginia, and director of the Virginia Geological Survey.

Webster, Arthur G., professor of physics, Clark University.

Welch, William H., professor of pathology, Johns Hopkins University, president of the National Academy of Sciences.

Wheeler, William M., professor of economic entomology, Harvard University.

Whitney, Willis R., director of the research laboratory, General Electric Company.

Wilson, Edmund B., professor of zoology, Columbia University.

Woodward, Robert S., president of the Carnegie Institution of Washington.

Cattell, J. McKeen, professor of psychology, Columbia University, *Secretary*.

SCIENTIFIC NOTES AND NEWS

Dr. Woldemar Voigt, professor of theoretical physics at Göttingen, will next year be the visiting professor from Germany to Harvard University.

On the recommendation of the council and of the special committee on the Hayden Award the Academy of Natural Sciences of Philadelphia has this year conferred the memorial gold medal on Henry Fairfield Osborn in recognition of his distinguished work in vertebrate paleontology.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, has received notice through the French ambassador in Washington that the cross of chevalier of the legion of honor has been conferred upon him by the president of the French Republic. This honor has been bestowed in recognition of the services which Dr. Flexner has rendered to medical science through his own discoveries and through his administration of the Rockefeller Institute. Special mention is made in the award of the assistance given to France at the time of the epidemic of cerebro-spinal meningitis, which prevailed in 1909, by sending to the Pasteur

Institute in Paris a supply of anti-meningitis serum which was successfully used in combating that epidemic.

SURGEON-GENERAL WILLIAM C. GORGAS, U. S. Army, has been awarded the Dr. Louis Livingston Seaman medal by the American Museum of Safety as a recognition of his work in making the Panama Canal Zone habitable and sanitary.

DR. JOSIAH ROYCE, since 1885 professor of the history of philosophy at Harvard University, has been transferred to the Alford professorship of natural religion, moral philosophy and civil polity, vacant by the retirement of Professor Palmer.

DR. JULIUS VON HANN, professor of cosmical physics at Vienna, has celebrated his seventy-fifth birthday.

PROFESSOR C. S. SHERRINGTON, Waynflete professor of physiology in the University of Oxford, has been elected a member of the Royal Danish Academy of Sciences.

ZÜRICH UNIVERSITY has conferred the honorary degree of doctor of natural sciences upon Professor Alfred Werner, of Zürich, winner of the last Nobel Prize for chemistry.

DR. LAWRENCE MARTIN, associate professor of physiography and geography at the University of Wisconsin, has been elected a corresponding member of the Kaiserlich-königliche Geographische Gesellschaft in Vienna.

SECRETARY LANE, of the Department of the Interior, has appointed Professor R. H. Fernald, of the University of Pennsylvania, as consulting engineer to the Bureau of Mines. He will be sent to England, France, Belgium, Germany and Austria to investigate improvements with gas producers in the development of metallurgical and power operations.

DR. HANS MURSCHHAUSER, of the Akademische Kinder-Klinik in Düsseldorf, has been appointed research associate of the Carnegie Institution of Washington, attached to the nutrition laboratory at Boston.

DR. FREDERICK M. MEADER has resigned as city bacteriologist of Syracuse, and has been succeeded by Dr. Oliver W. H. Mitchell, assistant professor of bacteriology and preventive medicine in the University of Missouri. Dr. Mitchell also succeeds Dr. Leverett D. Bristol as assistant professor of bacteriology in Syracuse University.

MR. ALFRED E. CAMERON, board of agriculture scholar in entomology, Manchester, England, is spending the summer at the entomological department of the Agricultural Experiment Station, New Brunswick, N. J. He has recently arrived from England.

PROFESSOR FRANCIS E. LLOYD, of McGill University, will spend the period from May 1 to September 15, at the coastal laboratory of the Carnegie Institution of Washington, Carmel-by-the-Sea, Calif.

MR. STEWART CULIN, curator of the department of ethnology of the Brooklyn Museum, is at present in the far east in order to collect ethnological material. His itinerary has taken him to Japan, China, Korea, India and Ceylon.

THE Congo expedition of the American Museum of Natural History under Messrs. Herbert Lang and James Chapin, which in cooperation with the Belgian government has been carrying on active field work in central Africa for the past four years, will return to New York early in the summer.

DR. HERMANN VON SCHRENK, pathologist to the Missouri Botanical Garden, delivered a series of five lectures before the members of the department of forestry of the University of Toronto, in March, on "Diseases of Trees and Structural Timbers."

MRS. CHRISTINE LADD-FRANKLIN gave, on April 20, 21 and 22, three lectures at the University of Chicago as follows: "The Bridge between the New Logic and the Old," "The Indispensable Requirements of a Color Hypothesis," "Graphic Representation of Color Relations and Recent Views on Color."

THE second open meeting of the Society for Biological Research of the University of Pittsburgh for the year 1913–14 was held on April 16, at which time Dr. John F. Anderson, director of the hygienic laboratory of the U. S. Marine Hospital and Public Health Service, gave an

address on the "Etiology and Distribution of Typhus Fever."

Dr. Barton Warren Evermann, director of the Museum of the California Academy of Sciences, delivered the address at the annual meeting of the Beta Kappa Alpha Society of the University of California, at Berkeley, on the evening of April 16. His subject was "The Alaska Fur-seal Herd and its Proper Management."

The building of the College of the City of New York, hitherto known as the Mechanic Arts Building, will, by vote of the trustees, hereafter be called "Compton Hall," after Professor Alfred G. Compton, late head of the department, who died in the autumn of 1913.

The municipality of Saint-Georges-sur-Cher has decided to erect a monument to Bretonneau, of Tours, one of the distinguished names in the history of French medicine, who was born there in 1774.

Philippe Edouard Leon Van Tieghem, eminent French botanist, died in Paris on April 28 at the age of seventy-five years.

Dr. Karl Chun, professor of zoology at Leipzig, distinguished for his oceanographic studies, has died at the age of sixty-two years.

Dr. Paul Ehrenreich, the distinguished ethnologist, docent in the University of Berlin, has died at the age of fifty-eight years.

Professor Adolf Fischer, director of the Museum for Asiatic art, founded last October at Cologne, has died at the age of fifty-eight years.

The medical college of Cornell University and the General Memorial Hospital will establish a cancer hospital, towards which it is said $1,000,000 have been subscribed, including $500,000 from Dr. James Douglas.

The cornerstone has been laid for a building for a Servian Academy of Science in Belgrade, the cost of which is to be about a million dollars.

The Memorial Institute for Infectious Diseases, of Chicago, has moved into its new building at 629 South Wood St., to which address all communications should be sent. This is also the new address of *The Journal of Infectious Diseases.*

The late Mr. Henry Bloom Noble, of Douglas, Isle of Man, left practically all his estate for educational and charitable purposes in the island. The trustees of his will have decided to devote £20,000 for the fostering of agriculture.

Through the generosity of Mr. George Manierre, of Chicago, the mounted skeleton of the American mammoth which has for many years been exhibited in the museum of the Chicago Academy of Sciences, has been transferred to the Field Museum of Natural History. This skeleton long remained the only mounted skeleton of the mammoth in America and it still forms one of the best representatives of this animal known.

The American Museum of Natural History has acquired from the estate of the late Edwin E. Howell, of Washington, a well-known collector and dealer, the entire collection of meteorites which belonged to his establishment at the time of his death. The collection consists of representatives of fifty-four falls and finds, aggregating about one hundred kilometers in weight. It includes two which have not been heretofore represented in the museum, namely, the Ainsworth and Williamstown irons. This acquisition was made possible through the generosity of Mr. J. P. Morgan.

After a conference with the trustees of the University of Pennsylvania following the close of the trial of Professor J. E. Sweet for cruelty to animals and the disagreement of the jury, Dean William Pepper, of the department of medicine, announced that the continuation of the experimental work in the medical school was authorized. It was agreed by all that the university owes it to humanity to continue the work without interruption.

Last spring the attention of the Maine Agricultural Experiment Station was called to maggots infesting blueberries towards the end of the season. Accordingly larvæ were reared and the insect ascertained to be the same species which infests the apple, *Rhagoletis pomonella.*

Apart from the governments and government departments which will be represented at the International Congress of Tropical Agriculture to be held at the Imperial Institute, London, from June 23 to 30, a number of societies, chambers of commerce and associations, foreign as well as British, have indicated their intention to support the congress, and most will send delegates. It is already known that the congress will be attended by members from the following countries: Austria, Egypt, France, Germany, Holland, Italy, Japan, Portugal, Russia, the United Kingdom, the United States, Ceylon, East Africa, Gold Coast, Honolulu, India, Jamaica, Java, Leeward Islands, Nigeria, Sierra Leone, Straits Settlements and Federated Malay States, Trinidad and Uganda.

It is announced that arrangements are being made for the holding in Edinburgh, in September next, of a conference on the various aspects of the physical sciences in their application to the study of the phenomena of weather. Sir John Murray had consented to act as president, but now new arrangements must be made. It is planned to open the conference on September 8, and to continue its work during the four following days. Those interested should send their names to the secretary of the organizing committee at the Meteorological Office, South Kensington, London, S. W.

The thirteenth general meeting of the Association of Economic Biologists was held at the Imperial College of Science and Technology, London, on April 10 and 11. Professor Robert Newstead presided. According to the report of the London *Times* Mr. A. G. L. Rogers, of the Board of Agriculture, communicated the results of the International Phytopathological Conference lately held in Rome with the object of considering how united action may be taken for checking the importation of plant diseases. There are two ways of dealing with a center of plant infection. The first is to forbid the entry of plants from the infected district or country. The alternative is for the administrative authorities in the infested country to take the necessary steps for extirpating the pest within their borders; and to issue a guarantee of freedom from infection with all lots of the suspected produce. This procedure is an impossibility in the case of the bulky crops of what in France is called "La Grande Culture," as no staff of specialists could deal with the amounts grown. The international delegates therefore unanimously agreed to exclude these (including all grains) and the grape vine from their provisions, the various nations being left to protect themselves from diseases of staple crops by individual action as at present. The recommendations, however, provide for including such produce as fruit, flowers and bulbs in the proposed convention, which at present awaits ratification, all the powers except the United States having provisionally agreed to the principle of united action. Certain powers, while not prepared to relinquish the right of inspecting imported produce included in the provisions of the convention, intimated their willingness to let these rights be in abeyance so long as exporting countries fulfilled their obligations.

It is planned to take the biological work of the University of Utah Summer School to a mountain laboratory during the last three weeks of the course. Animal ecology and some systematic study of flowering plants will be the parts of the work best adapted to this plan. The regular session will begin on June 8 and close on July 17, the change of base for biology to be made on June 26. Silver Lake, at the head of Big Cottonwood Canyon, thirty miles from Salt Lake City, altitude 8,728 feet, has been chosen as the spot for beginning mountain station work in Utah. Here in a setting of rugged peaks lie a half dozen small gems of mountain lakes, one at an altitude of 9,920 feet, and a beautiful little mountain valley in which rise from innumerable sources the headwaters of Big Cottonwood Creek, a typical mountain stream. From the tops of these peaks to the warm and hot springs, the sulphurous and salt waters, the desert and the Great Salt Lake itself in the valley near the university, stretches a wide va-

riety of conditions to receive attention in ecology. Persons desiring further information may communicate with Dr. Charles T. Vorhies, University of Utah, Salt Lake City.

Mr. C. V. Hodgson, of the Coast and Geodetic Survey, Department of Commerce, has recently left Washington for the southwestern part of the United States, where he will have charge of a party for the determination of the astronomic latitude of triangulation stations established by the Coast and Geodetic Survey and the United States Geological Survey, between Barstow, Tex., and the Pacific Ocean. Many of these stations are on mountains as much as 10,000 feet in height. The results of this work will be used principally for geodetic purposes, that is, the determination of the figure of the earth and the distribution of material in the earth's crust. The means of transportation for this party will be a 1½-ton automobile truck which was used successfully on similar work between Denver, Col., and the Canadian border in the season of 1913. A similar truck had been employed also in 1912 on the 49th parallel boundary survey between the United States and Canada. The cost of the work during the season of 1913 is estimated as only one half what it would have been if horses and wagons had been used for transportation. The saving in the coming season is expected to be even greater, as the country to be traversed is arid or semiarid and the transportation of water and forage for stock would have been a difficult problem. It is expected that the work will continue until late in the autumn.

UNIVERSITY AND EDUCATIONAL NEWS

The new buildings of Zürich University were formally opened on April 19. The buildings, which cost about $1,700,000, stand on rising ground overlooking both lake and city.

Dr. Theodore C. Janeway, Bard professor of the practise of medicine in Columbia University, has accepted the professorship of medicine in Johns Hopkins University under the full time basis made possible by the gift of $1,500,000 by the General Education Board.

Dr. Mazyck P. Ravenel, professor of medical bacteriology in the University of Wisconsin, and director of the public health laboratory, has accepted the chair of preventive medicine in the University of Missouri.

The board of regents of the State University of Washington has appointed a committee of three to consider the selection of a president and has requested the faculty to choose a like committee, which it has done by secret ballot. This joint committee will report to the faculty and to the regents.

Dr. E. R. Clark, associate in anatomy at Johns Hopkins University, has accepted an appointment to the chair of anatomy in the University of Missouri.

Dr. Leverett D. Bristol has left Syracuse University to take charge of the North Dakota state laboratory.

At the College of the City of New York Professor William Fox has been made full professor of physics and head of the department and Professor Laurel has been promoted to be full professor of mathematics.

Dr. William Hallock Park, professor of bacteriology and hygiene in the New York University and Bellevue Hospital Medical College, has been elected dean of the college by the council of New York University to succeed the late Dr. Egbert le Fevre.

Dr. Albrecht Bethe, professor of physiology at Kiel, has accepted a call to Frankfort.

Professor Dr. H. Merkel, professor of pathological anatomy at Erlangen, has been called to Munich.

DISCUSSION AND CORRESPONDENCE

MULTIPLE FACTORS IN HEREDITY

In Science, April 10, 1914, Professor Ramaley refers appreciatingly to the work of Dr. MacDowell on size inheritance in rabbits, which was carried out in my laboratory, and concludes that this work essentially substantiates Davenport's conclusion that the apparent blend of human skin color in mulattos is due to two distinct Mendelizing factors possessed by the negro, but lacking in the white races.

Professor Ramaley's note might lead one to infer that since Dr. MacDowell's work was carried out under my supervision and since his paper has been published with my approval, therefore I (in common with Mendelians generally) share the views expressed concerning Mendelian factors in size inheritance, but this is not entirely true, and to avoid further possible misunderstanding I write this note. Dr. MacDowell's observations I believe to be accurate; they were made with great care and were checked in every possible way. I have kept in close touch with his work at every stage of its progress and have found it unimpeachable. Few investigators with whom I have been associated have shown such aptitude for exact and critical work as he displayed from the beginning. I endorse his observations fully.

But the facts observed are capable of different theoretical interpretations. In regard to these I have encouraged in Dr. MacDowell the fullest freedom of choice. He has adopted one for which much can be said, that of multiple Mendelian factors, which at times has appealed to me strongly, and the argument for which I have presented elsewhere ("Heredity," D. Appleton & Co., 1911) at some length. This theory has also been developed independently by Lang (1910), East (1910), Emerson (1910) and others. It accounts for the facts fully if certain basic assumptions are allowed, about which, however, I am growing more skeptical the more closely I examine them. Dr. MacDowell, in the passage quoted by Professor Ramaley, truthfully says of this theory, "It goes hand in hand with the mutation and pure-line doctrines of De Vries and Johannsen." But suppose one is not prepared to accept those doctrines, what then becomes of the multiple factor hypothesis? It is left without adequate basis. If the multiple factor hypothesis must stand or fall with the pure-line doctrine, I for one can not accept it, for the foundations of the pure-line doctrine appear to me very insecure.

What in brief are the facts regarding size inheritance which call for explanation? Fortunately, observers are quite in agreement concerning them.

1. Occasionally an unmistakable Mendelizing factor is concerned in size inheritance. One was discovered by Mendel himself (1866) and its existence has been repeatedly verified, namely, the differential factor between tall and dwarf races of garden-peas. Tall and dwarf conditions in other plants behave in a similar way, that is as Mendelian alternative conditions showing both dominance and segregation in crosses. Brachydactyly in man is a variation like dwarfness in plants, in which the growth habit is altered, the skeleton being abnormally short and compact throughout. This character is a Mendelian dominant (Farabee, 1905, Drinkwater, 1908). The shorter, more compact form of Dexter cattle, in contrast with the Kerry breed, is a Mendelian character (Jas. Wilson, 1909) probably similar in nature. Doubtless the same was true of the short-legged Ancon sheep mentioned by Darwin (1878, "Animals and Plants").

From the mere fact that a Mendelian factor may be involved in a size difference, it by no means follows that *all* size differences are due to Mendelian factors. Such Mendelizing factors affecting size as have just been enumerated are distinctly rare. They are not discoverable at all in the cases studied by MacDowell, which involve neither dominance nor segregation in a 1:2:1 ratio. Even in cases involving an unmistakable Mendelian factor, as the tall-dwarf cross in peas, it is not to be supposed that no other factors affect size. For are all dwarf peas of the *same* height, or are all tall peas of the same height? No, there are differences among each sort, differences which are heritable also, since one dwarf variety differs from another in its mean height.

2. Ordinary differences in size (such as do not involve a change in the growth habit) among animals or plants do not Mendelize in the ordinary acceptation of the term. When races are crossed which differ widely in size, the first filial (F_1) generation is intermediate between the parents and often not more variable than one of the parent races. But the

second filial (F_2) generation, though still intermediate, commonly shows increased variability, the range of which may even extend into or include the size range of one or both parent races. This *increased variability* of the F_2 generation is the only evidence of Mendelism in size crosses. In 1911 I was inclined to regard it as *sufficient* evidence, but in this I was clearly mistaken, as a moment's consideration will show. It would be sufficient only (1) if the size differences were due *wholly* to Mendelian factors, and (2) further these factors were invariable, that is quantitatively always the same. But neither of these assumptions can be regarded as established. On any hypothesis size differences must depend on many mutually independent factors or causes. This is the prime significance of a frequency-of-error variation curve, however produced. It would be rash to assume that all the factors concerned are *Mendelizing* factors, in the total absence of the two usual accompaniments and criteria of Mendelism, dominance and segregation in recognizable Mendelian ratios.

The question whether Mendelian factors are constant or inconstant has been discussed from different points of view by my colleague Dr. East and myself in the *American Naturalist* (1912), he maintaining their constancy on the ground that they are subjective merely, while I have thought it necessary to assume for them an objective existence in the germ-cell, and am unable to discover any evidence of their constancy from the behavior of germ-cells. It is, of course, possible, as Dr. East maintained, to formulate a description of all heredity in terms of (purely subjective) Mendelian units, provided more and more units are from time to time created (by imagination) as the objective facts show the organism changed. But such an extension of Mendelism fails to interest me, as I think it does many of my readers. What we want to get at, if possible, is the objective difference between one germ-cell and another, as evidenced by its effect upon the zygote, and it is the constancy or inconstancy of these objective differences that I am discussing. If these are quantitatively changeable from generation to generation, then change in the variability of the zygotes composing a generation might arise without factorial recombination.

By way of illustration let us consider the simplest conceivable case. Suppose two organisms to differ by a single genetic factor for size. Suppose one organism to be of size 4, the other of size 8. On crossing, if each transmits its own condition and dominance is lacking, an intermediate is formed, size 6. On the theory of gametic purity, the gametes formed by this heterozygote of intermediate size (6) should be 4 and 8, respectively, and the next generation of zygotes (F_2) should be as follows:

Classes of zygotes	4,	6,	8,
Expected frequencies	1,	2,	1.

Here we note that a large part of the F_2 generation is intermediate in character, as was F_1, but F_2 is more variable than F_1, falling into three classes instead of one. This is the regular Mendelian way of viewing size inheritance, gametic purity being assumed. But is the assumption necessary or justifiable? Suppose the assumed size factor were *modifiable* or partially blending, so that 4 and 8, after association in the F_1 zygote, emerged as 5 and 7, respectively, in the gametes. Then F_2 would be:

Classes of zygotes	5,	6,	7,
Expected frequencies	1,	2,	1.

In this case, as well as in the supposed case of pure gametes, we should observe an F_2 more variable than F_1, though the *extreme* conditions of the parent organisms crossed would not be attained in F_2 (as, in fact, they rarely are). But even the recurrence of such extreme conditions as those of the grandparents might be explained as due to occasional failure of the gametes associated together in F_1 to modify each other.

Now I do not advocate either of these explanations. I present the second merely to show that the first is not the only conceivable explanation, and that I was earlier wrong in supposing an *increase* of variability *prima facie* evidence of the occurrence of *more than* a single Mendelizing factor. It might equally

well be regarded as evidence of a *single* Mendelizing factor, quantitatively variable.

If we set out by assuming that a Mendelian factor is invariable, then we are forced to assume, whenever genetic variation is observed in an organism, that this is due to an *additional* Mendelian factor. This is the real basis of the multiple factor hypothesis as applied to size inheritance, though not, of course, the historical one. But to reason thus is merely to pile one assumption upon another, which is not to advance science, whatever it does for a system or a terminology; but with these we are less concerned than with knowing the exact truth and in stating it as clearly and concisely as possible.

What now of human skin color, is this or is it not Mendelian in inheritance? At present I consider this largely a question of terminology. The *facts* appear to be very similar to those observed for body-size in rabbits, and for other quantitative characters in animals and plants. F_1 is intermediate; F_2 is also intermediate, but more variable than F_1. If we call this Mendelism, we shall need to explain that it is not the Mendelism of Mendel himself, but original Mendelism *plus* (1) the assumption of gametic purity, *plus* (2) the assumption of factorial constancy, *plus* (3) the assumption of factorial multiplicity.

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FOREST HILLS, MASS.,
April 15, 1914

JAVEL WATER—A SIMPLIFIED AND CORRECTED SPELLING

IN his "Grand dictionnaire universel du XIXé Siécle" (Paris, 1873), Pierre Larousse tells us that there used to stand upon the banks of the Seine in the suburbs of Paris in what is now the "XVe arrondissement" a solitary mill, sheltered by trees, where bathers and fishermen used to rest and partake of refreshments. This mill was known as the "moulin de Javel" and the lexicographer elsewhere states that this word is a variant of *javeau*, which means an island of sand and mud, a sandbank, although in this instance it is no doubt a proper name. The word *javelle* (cf. English, provincial, gavel), signifying an unbound sheaf or a bundle of grain smaller than a sheaf, is of different origin.

Upon the site of the old mill the village of Javel was founded in 1777 by the Count of Artois, who established a chemical works. The first directors of the works, Messrs. Alban and Vallet, were the originators of Javel water, which they prepared in 1792 by passing a current of chlorine through a solution of 2.440 kilos of "sub-carbonate" of potassium in 17 kilos of water. Larousse also refers explicitly to the erroneous spelling *eau de javelle*, employed by some authors. Littré in his "Dictionnaire de la langue française" (Paris, 1873) employs this erroneous spelling.

Unfortunately, the dictionary of the French Academy (7th edition, Paris, 1878) sanctioned the spelling "Javelle" for both the name of the mill and the derived name of the bleaching liquor, adding error to error in describing the liquid as a solution of potassium *chloride* in water ("L'eau de javelle est du chlorure de potassium en dissolution dans l'eau").

With such authority behind it, it is not surprising that the *-elle* ending has come into very general use. Yet a number of the more careful French and English writers employ the correct form of the word. Among such are Girard in "La grande encyclopédie" (article "Chlorures décolorants"); Emile Bouant in his "Dictionnaire de chimie" (Paris, 1888); Moissan in his "Chimie minérale" (1904–6); Edmund Knecht in the Encyclopedia Britannica, eleventh edition (article "Bleaching"); and Sir Edward Thorpe in his "Dictionary of Applied Chemistry" (1912). In Germany and America, as far as I have observed, the erroneous spelling is universally adopted. And our dictionaries of the English language appear likewise to be unanimously wrong. Not even the New Standard Dictionary (1913), which gives the simplified spellings of the Carnegie board, makes the least reference to the shorter form of this word.

A certain amount of confusion is prevalent also regarding the signification of the term

"Javel water." Originally it meant the liquor prepared by action of chlorine on dilute potash solution. In so far as its bleaching effect is concerned such a liquor is essentially a solution of potassium hypochlorite. It was inevitable, however, that when, through the cheapening of sodium compounds, potassium hypochlorite was superseded by the sodium salt, the name popularly applied to the bleaching liquor should undergo a change in signification. The fact that sodium hypochlorite solution was already employed in pharmacy under the name of *Labarraque's liquor* could not affect this change. Pharmaceutical language is too esoteric and popular habit too persistent to render it possible for the pharmaceutical term to supplant the established usage of the textile trade. I take it, then, that we must expect the sodium hypochlorite-chloride mixture to continue to be known as "Javel water." Such confused statements, however, as the following—let us hope a slip of the pen—are not to be excused even in a writer whose subject is one relating to textile chemistry. It occurs at p. 234 of Pellew's "Dyes and Dyeing," an excellent popularizing exposition of the triumphs of synthetic chemistry in this fascinating field:

> The potash and soda compounds, known respectively as Labarraque's solution and Javelle water, are less active and powerful than bleaching powder, but have the same general properties.

It is to be hoped that Mr. Pellew's readers will not be misled by either his definitions or his spelling.

J. F. Snell

Macdonald College,
Quebec, Canada,
February 27, 1914

SCIENTIFIC BOOKS

Manual of Petrographic Methods. By Albert Johannsen, Ph.D., Assistant Professor of Petrology, the University of Chicago. New York, McGraw-Hill Book Co. 677 pages, 770 figures in text and as whole page plates. $6.00 net.

The methods of microscopic petrography, like other laboratory methods, have advanced steadily in number and in complication during the fifty years of their practise, keeping pace with the increasing number of workers, the aim at greater accuracy and the developments of the petrographic microscope and its accessories. The author states in the preface that "the desire of an increasing number of students for more complete information in regard to modern petrographic-microscopic methods than is to be found in any English work on the subject" has led to the preparation of this book, but the reviewer knows no more complete and up-to-date treatment of this special subject in *any* language, for in most cases such works combine the general and theoretical part with a description of the individual minerals, while in this work only the methods are dealt with, but with a thoroughness, especially regarding the applications of optical mineralogy, which is of great value to the advanced student and investigator. Beginning with a short introductory chapter on crystallography and a thorough treatment of stereographic projection (so necessary for some of the more recent microscopic methods), chapters follow on the transmission of light through crystals, with a very complete and practical treatment of such topics as lenses, the petrographic microscope and the innumerable accessories which are now available, while the following chapters, comprising 300 pages, or nearly half the book, give a very complete account of the practical methods of application of the principles and instruments previously described. A somewhat briefer but sufficient account of the determination of specific gravity, mechanical separation of rock minerals, microchemical reactions, preparation of thin sections, etc., fills the remaining pages. The book is clearly printed and compact, notwithstanding the extended text and many figures; it represents a vast amount of careful, discriminating and constructive work on the author's part, as, for instance, is shown by the bibliography at the end of each chapter, and should be invaluable in its special field.

John E. Wolff

Harvard University

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. XIII. Noctuidæ (part). By SIR G. F. HAMPSON, Bart. London, 1913. Pp. xiv + 609.

In this volume the consideration of the Noctuidæ is continued, the subfamily Catocalinæ being concluded from Vol. XII., the Mominæ and Phytometrinæ (better known as Plusiinæ), being given in full. There are 70 genera and 679 species included, besides some unrecognized ones. Colored plates CCXII. to CCXXXIX. accompany the volume.

Some of our most familiar names disappear, not by necessity, but by the author's non-recognition of the names in Hübner's "Tentamen" and "Zuträge." *Euclidia* Hübn. (Tent.) is replaced by the totally unfamiliar *Gonospileia* Hübn. (Verz.); *Agnomonia* Hübn. by *Argyrostrotis* Hübn. (Verz.); *Plusia* Hübn. (Tent.) by *Phytometra* Haw., which changes the familiar sub-family Plusiinæ to Phytometrinæ. However, this is in part set off by the retention of *Phurys* Guenée, which should have been replaced by *Crochiphora* Hübn. (Zutr.). According to the rules of nomenclature it appears to us that Hampson is clearly wrong in discarding these names.

On page 188, my species *distilla* is made a synonym of *Safia amella* Guen., but it is, in fact, abundantly distinct.

On page 207, *Zale* Hübn. is used instead of *Phæocyma* Hübn., by page priority, although the late J. B. Smith used *Phæocyma* in the monographic treatment of the American species. We are in favor of Hampson's action, and mention it only because it was held at the National Museum at the time that Smith could use either name he chose.

On page 331 some corrections of previous volumes appear. Our familiar genus *Erebus* replaces *Nyctipao* (Vol. XII., p. 273), a purely Asiatic genus and is lost to us. Likewise *Melipotis* Hübn. replaces *Ercheia* Walk., an old world genus, and disappears from our lists.

Under the Mominæ, my genus *Zasunga*[1] should have been included, with two species *setacelis* and *opinor*. It would fall in the table with *Elydnodes*, but the thorax is clothed with hair only.

HARRISON G. DYAR

[1] *Proc. U. S. Nat. Mus.*, XXXVIII., 251, 1910.

Einführung in die Vererbungswissenschaft. By RICHARD GOLDSCHMIDT. Second edition. Leipzig, Wilhelm Engelmann. 1913. Pp. 546. Price 14 marks.

The second edition of this work has been somewhat enlarged and in part rewritten. The first alteration to challenge attention is the thorough rearrangement of certain parts of the book. The chapters on Mutation and on the Inheritance of Acquired Characters are related to one another, and both are deferred to near the end of the book, after the sections on hybridization and sex determination. In the first edition those chapters are in the early part of the book, immediately after the discussion of variation. Graft hybrids and chimeras, instead of following hard upon Mendelian hybrids, are not discussed until after sex determination. Other chapters of the old edition are divided and the parts recombined. For example, the cellular basis of heredity is taken up in connection with sex determination, instead of independently; while minor sections are freely shifted under new captions. These changes appear to the reviewer to be in the interest of logical presentation.

The most extensive addition to the book is in the treatment of sex determination, sex inheritance, etc. These chapters are enlarged to the extent of about 35 pages. The striking feature of this enlargement is a proposed new formula for sex inheritance. Each sex is represented as containing factors for both sexes; one sex is homozygous for both these factors, the other is heterozygous for one of them and homozygous for the other. The factors are then weighted, in a manner not unlike that proposed by Spillman,[1] so that in one case femaleness, in the other maleness, come to expression. This formulation thus maintains the form of Mendelian inheritance, but contains elements of the quantitative theory of sex determination. The formula

[1] Spillman, W. J., *Amer. Nat.*, Vol. 44, 1910, pp. 214–228.

applies as well to species in which the female is the heterozygous sex as to those in which the male is heterozygous. The author does not hesitate to locate these factors in the chromosomes (though only one of them is in the X-chromosomes), and he is at considerable pains to show how this representation may be in harmony with the facts regarding several well-known cases of sex-limited inheritance. Crossing over (Morgan) is a modification of the regular process, but in no wise a contradiction.

Chapter XIII. is largely new. It relates to polymery, interference of genetic factors, sterility of hybrids and coupling of factors. Breeders, especially in Germany, come in for some sharp criticism for not adopting Mendelian methods and terminology. Inheritance in man is discussed in the final chapter of the book, which is new, and an extensive list of literature appearing from 1911 to 1913 is added to the old bibliography.

Numerous other changes, both additions and emendations, are made elsewhere. Many of these are made for pedagogical reasons. Some are of interest as indicating possible changes of the author's opinion. Thus, the author is now more inclined than formerly to regard the mutability of *Œnothera lamarckiana* as due to the hybridity of that species. He now leans more to the "Presence and Absence" theory of Bateson as representing the real truth. The chapter on inheritance of acquired characters is clarified, but the author's views are apparently little changed.

In a growing subject a book can scarcely be without errors. Thus, the four armadillo embryos of a litter are still referred to the first four blastomeres of the egg, whereas the reasons for so regarding them seem to have disappeared in the work of Patterson.[3] Typographical errors are few. Unfortunately, several of these have crept into the illustrations, but attention is directed to them in the legend.

The book is so good, however, that one can overlook its few faults. The new edition is plainly an improvement over the old. One could wish it were to be translated into English for the benefit of the American students who will not read it in the original.

A. Franklin Shull

[3] Patterson, J. T., *Jour. Morph.*, Vol. 24, No. 4, 1913, pp. 559–662.

Solvents, Oils, Gums, Waxes and Allied Substances. By Frederic S. Hyde, S.B. Consulting Chemist, New York. New York, Van Nostrand. 1913. Price $2.00.

These notes are for the use of factory chemists who wish a book on the subjects named which shall be condensed and authoritative.

The title suggests one of the good features of the book, that which gives the solvents for many of the substances mentioned; besides this, however, methods are given for the analysis of these compounds. In attempting to cover such a wide field it is not surprising that inaccuracies have crept in. For example, the statement regarding the Maumené-Sherman test (with sulphuric acid) is in error, as no dilution of the oil is necessary when using the ninety per cent. acid. The general unreliability of the Valenta test is not clearly stated. It is to be regretted that the "saponification equivalent" is again revived as it is infrequently met with at present. It should be noted that the New York State Tester is not commonly used for the ordinary lubricating oil—the Cleveland Cup is the one commonly employed. In the analysis of paints no reference is made to the use of the convenient centrifuge.

The book is one which will be very useful to all having to do with these substances.

A. H. Gill

SPECIAL ARTICLES

ADAPTATION OF THE TAMARISK FOR DRY LANDS

Although a specialist in the line of cereal investigations, the writer has had occasion during the past ten years, in connection with grain experiments in dry-farming in the Great Plains and Western States, to observe the comparative adaptation to conditions of drought of various orchard and forest trees. While certain trees, such as the black and honey locusts, the elm, Osage orange, hack-

berry and Russian mulberry, are generally known to be adapted for dry-land farming, it is surprising to find that so little attention has been given to the tamarisk as a shrub, or small tree, suitable for hedges and shelter belts, though the experience of the writer has shown it to be absolutely unequaled for this purpose. Only four experiment stations at present come to mind where the tamarisk is grown at all, and, even in these places as a rule, only for ornament or as a curiosity. These are the New Mexico Experiment Station, the Hays Branch Experiment Station, in Kansas, the Arizona Experiment Station at Tucson, and the Fallon Experimental Farm on the Truckee-Carson Irrigation Project in Nevada. At the last named place, however, it is being employed experimentally and from a practical standpoint because of its qualities above mentioned.

It is peculiar that the tamarisk is listed by a number of nursery companies as an ornamental for the humid areas of eastern United States and is commonly employed in that way. Rarely is any mention made in nursery catalogues of its adaptability for dry-land conditions. The writer was made acquainted with its drought-resistant qualities accidentally through having obtained a single specimen for planting in a yard in the southwestern plains. It was soon found to be by far the most drought-resistant and otherwise hardy of all the trees and shrubs planted on the same land, including about twenty species. There appears to be no limit in dryness of the soil on any usual Great Plains' farm beyond which this plant will not survive. It is also best fitted for saline soils of all plants yet known to the writer. It has an extremely rapid growth, and, by branching out close to the ground, produces an excellent close hedge which will soon turn some kinds of stock even with its absence of thorns. None of the species known to the writer grow very tall, not ordinarily more than twenty feet, though two rather old specimens have been observed near the courthouse at Tascosa, Texas, 12 to 15 inches in diameter.

To the ordinary observer, not a specialist in botany, the plant is best described by saying that it most resembles asparagus. It has a tendency to make a very scraggy growth and will not grow erect with the lower limbs very far from the ground unless carefully and constantly pruned to that end. Botanically it belongs to the order Tamariscineæ. It bears very small scale-like leaves and small pink or white flowers, which are either four or five parted.

On the land above mentioned, situated in the western portion of the Texas Panhandle, the writer has tried the method (also suggested by the editor of *The Oklahoma Farm Journal*) of dividing cultivated ground into narrow fields several times as long as broad, extending with their greatest dimensions east and west, and planting narrow belts of trees on the south sides of these fields to check the blowing of the soil, which method, so far, is found to be excellent. The trees employed in planting these belts were usually black locust, honey locust, Osage orange and Russian mulberry, but it is now the practise to plant tamarisk as the first row on the south side of each of these belts.

An interesting thing about tamarisk, and of the greatest importance where these trees are adapted and where nursery stock is not easily obtained, is the fact that the plant can be readily and rapidly propagated by means of cuttings. After two or three years' growth, therefore, of from one to one dozen specimens there need be no further purchase of stock, as there is then plenty of material in the way of cuttings from these trees for all ordinary planting purposes. If advantage is taken of an opportunity to put the cuttings in the ground just after a rain, no further attention is needed other than good cultivation, and during an average season on the driest farms in the Great Plains the trees will thereafter succeed without any question.

In the Kew Index there are listed about seventy species of tamarisk which are found in various parts of the world, but none are native in North America and, apparently, only a half dozen at most are found in Europe. Alfred Rehder has given a good account of the genus

in Bailey's "Cyclopedia of Horticulture." The plant seems particularly at home in northern Africa and in the immense semi-arid and desert region comprising the Aralo-Caspian district, Russian Turkestan, Arabia, Persia, etc. The following eleven species are listed by nurserymen in this country, but the accuracy of the names is not yet determined: *Tamarix Parviflora, T. Algerica, T. Amurensis, T. Odessana, T. Chinensis, T. Gallica* and variety *Indica, T. hispida* (= *T. Kashgarica*), *T. juniperina* (= *T. Japonica* and *T. plumosa*), *T. tetrandra* and *T. Germanica*. *T. Germanica* and eight or nine others are now, however, referred to *Myricaria*.

The most common species in cultivation in this country appear to be *T. parviflora* and *T. gallica*, the latter originating in southern France. Discussions on the tamarisk have commonly referred to it as being of African origin. For our Great Plains and the drier portions of the western states most likely the species of Siberian origin would be best adapted. Numerous specimens have been introduced into this country by the U. S. Department of Agriculture, chiefly from China and Chinese Turkestan.

It is very important not to confuse the tamarisk with the tamarack, an extremely different plant, adapted in fact to marshes.

These few notes on the above subject are offered with the hope that interest will be stimulated in much more extensive plantings of this remarkable drought-resistant and alkali-resistant shrub in the districts in this country where it is adapted.

MARK ALFRED CARLETON
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

FINANCIAL STATEMENT OF THE PERMANENT SECRETARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

L. O. Howard, Permanent Secretary, in account with the American Association for the Advancement of Science. From November 1, 1912, to October 31, 1913.

Dr.

To balance from last account:		$7,836.40
Admission fees	$2,760.00	
Annual dues, 1913	20,891.75	
ditto 1914	119.00	
ditto previous yrs.	302.00	
Associate fees	15.00	
Life membership fees.	800.00	
Publications	57.25	
Bindings	5.00	
Jane M. Smith Fund...	5,000.00	
Interest	78.69	
Unclassified receipts, including postage and Treasurer's payment on SCIENCE subscriptions for Life Members	615.53	30,644.22
		$38,480.62

Cr.

By publications:		
Publishers SCIENCE....	$14,796.45	
Proceedings, Vol. 62..	1,901.09	$16,697.54
By expenses Cleveland meeting:		
Secretaries' expenses and commutations ..	540.09	
Badges, assistance and general expenses	115.71	655.80
By office expenses, including propaganda work:		
Postage	1,623.51	
Stationery, circulars and misc. printing	789.10	
Extra clerical help	653.85	
Engraving and printing certificates	105.00	
Telegrams, telephone, expressage, office supplies, etc.	463.25	3,634.71
By salaries:		
Permanent Secretary ..	1,500.00	
Assistant Secretary ...	1,500.00	3,000.00
By miscellaneous disbursements:		
To Treasurer (Jane M. Smith Fund)	5,000.00	
To Treasurer (life membership fees)	1,400.00	
To dues returned	13.00	6,413.00
By balance to new account..		8,079.57
		$38,480.62

The foregoing account has been examined and found correct, the expenditures being supported by proper vouchers. The balance of $8,079.57 is with the following Washington, D. C., banks:

American Security & Trust Co.....	$3,994.11
American National Bank of Washington	4,085.46
	$8,079.57

(Sgd.) THEO. N. GILL,
Auditor

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

SOCIETIES AND ACADEMIES

BOTANICAL SOCIETY OF WASHINGTON

THE ninety-third regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., Tuesday, January 6, 1914, with 42 members and 5 guests present.

Application for membership of Messrs. H. Pittier, Arno Viehoever and Raymond B. Wilcox were read. Messrs. Charles Thom, Charles S. Ridgway, George D. Clark, Clarence W. Carpenter, William A. Dayton, Orlo A. Pratt and Nathan R. Smith were elected to membership.

Mr. F. L. Lewton called attention to the discovery of the records of the Washington Botanical Club, the predecessor of this society from 1898–1902. He stated that these records were missing when the history of the society was written up a few years ago, and also gave a brief review of the club.

The scientific program was as follows:

The James River Hybrid Walnut: PETER BISSET. (With lantern.)

Lantern slides were shown of a walnut tree on the Rowe Farm, on the James River, opposite Lower Brandon, Va. The tree is 100 ft. high, with a spread of 123 ft., although until a recent storm the spread was 134 ft. At 4 ft. from the ground the tree is 31 ft. 3 in. in circumference, and at 6 ft. from the ground is over 25 ft. in circumference. At 12 ft. from the ground it divides into four large branches, three of which are larger than any tree in the neighborhood. No one has any definite knowledge of the age of the tree, but as the old farmhouse was built about 200 years ago it is supposed that the seed was planted at that time. Its growth was probably rapid, judged from seedlings which attained a height of 5 ft. 10 in. in one season, as compared with 3 ft. in seedlings of *Juglans nigra* which grew beside them. A seedling planted nearby about 1860 is now 2½ ft. in diameter and of the height of the parent tree. The characters of the leaves and nuts are such as to suggest a possible hybrid origin. The pubescence of the branches and leaves agrees with *Juglans cinerea* and the fruit and other leaf characters suggest *Juglans regia* instead of *J. nigra*. The nuts are of low vitality and very thick shell.

Smelter Injury in Southeastern Tennessee: DR. G. G. HEDGECOCK. (With lantern.)

To be published in the *Journal of the Washington Academy*.

Some Chinese Horticultural Brassica Species: DR. D. N. SHOEMAKER. (With lantern.)

Horticultural forms of Chinese Brassicas in the United States at present are: Three well marked varieties of mustard, *Brassica juncea*. These are well established in the American seed trade. Four types of non-pungent brassicas, of uncertain specific relations: (1) The heading forms, Chinese name *Pai Tsai*. These make long heads resting on the surface of the ground, and present many varieties. (2) A form with long broad petioles, and long light green leaf blades, the veins of which are quite prominent. (3) A form with very broad short flat petioles, and dark green leaf blades. These usually send up swollen seeding stems. (4) A very loose-leafed round petioled form, used by the Chinese as a summer vegetable.

THE ninety-fifth regular meeting of the society was held at the Play House on Tuesday evening, March 3, 1914, at eight o'clock, at which the retiring president, Dr. W. W. Stockberger, delivered an address on the social obligations of the botanist (to be published in SCIENCE).

The ninety-sixth regular meeting of the society was held at the Cosmos Club, Tuesday, April 7, 1914, at eight o'clock.

Messrs. Robert B. Whitney and H. S. Westover were unanimously elected to membership in this society.

The scientific program was as follows:

Professor A. S. Hitchcock reviewed (*a*) a paper by Trabut in which he states that the oats commonly cultivated in temperate regions descended from *Avena fatua*, the Algerian oat from *A. sterilis* and *A. strigosa* from *A. barbata*; (*b*) a paper by Schulz on the origin of wheat in which he states that *Triticum monococcum* descended from *T. ægilopoides*, *T. dicoccum* from *T. dicoccoides*, and *T. spelta* from an as yet undiscovered wild form; that the naked wheats are derived from the spelt wheats, *T. turgidum*, *T. durum* and *T. polonicum* from *T. dicoccum*, and *T. vulgare* and *T. compactum* from *T. spelta*.

Dr. H. L. Shantz reviewed a paper by Sir Francis Darwin.[1] A method by which the influence of stomatal adjustment on the rate of transpiration is eliminated. The stomata of the lower surface of the leaf are locked with cocoa butter or petrolatum and incisions made through the upper epider-

[1] *Proceedings of the Royal Society*, Series B, Vol. 87, February, 1914.

mis, thus connecting the intercellular spaces with the outer air. By this method transpiration was found to decrease proportionally as relative humidity increased. The straight line relation led to the conclusion that a relative humidity of 105 would be required to reduce transpiration to zero.

C. S. Scofield, "Chinese Wild Rice," with lantern (to be published later).

Dr. P. Spalding, "Present Status of the White Pine Blister Rust," with lantern (to be published as a bulletin of the Department of Agriculture).

R. Zon, "Meteorological Observations for Purposes of Botanical Geography, Agriculture and Forestry," with lantern.

The inadequacy of the present climatic data for the purposes of botanists lies not so much in the kind and character of observations that are being recorded as in the manner of their classification, their grouping and computing.

To properly understand plant life, it is essential to group meteorological data by actual periods of growth and rest. During each of these two periods plants react to temperature of the air in an altogether different way. The temperature records of the temperate region of the United States should be computed separately on the basis of the normal monthly mean not reduced to sea level for the period of rest or the period of growth, and in some localities also for a third period, the hot period. The period of rest should include all months having a normal mean temperature of 48° F. or less. The period of growth should be included, all months having a normal monthly temperature of from 50° to 72° F. The hot period in temperature latitudes should embrace months with a normal average temperature of more than 72° F.

A map showing localities with the same duration of the periods of growth and rest has been tentatively prepared.

Aside from monthly mean temperatures the average temperatures by periods of ten days (decades) are also desirable, and also the mean temperatures for periods when the ground is covered with snow and periods when the ground is bare. Similarly, the mean temperature for each period during which certain winds prevail.

Summation of temperatures, as suggested by Bussengo and de Candolle, do not indicate the actual requirements of plants for heat, since they overlook the existence of an optimum temperature for the development of each plant.

Groups of days with a given temperature are considered preferable, and the following classification is suggested:

1. *Freezing days*, with a daily average of 32° or less. These are further subdivided into: (*a*) Freezing days without thawing; (*b*) freezing days with thawing.

2. *Cold days*, with an average daily temperature ranging from 32° to 40° F. This group should be further divided into: (*a*) Days with frost; (*b*) days without frost.

3. *Cool days*, with an average daily temperature from 40.1 to 50° F. This group should be divided into: (*a*) Days with frost; (*b*) days without frost.

The paper discussed also the temperature of the soil, humidity of the air, precipitation, snow cover, soil moisture, sunshine and barometric pressure.

P. L. Ricker,
Corresponding Secretary

THE ST. LOUIS ACADEMY OF SCIENCE

"Mounds and Mound Builders" was the subject of a lecture by Dr. H. M. Whelpley, at the February 16 meeting. It was illustrated with lantern slides.

The lecture dealt particularly with the mounds of Illinois and Missouri. Strictly speaking, there was no race of mound builders, mounds having been built by primitive peoples, the world over. Indian mounds were discussed and their various types explained. The important Cahokia Group, in Madison Co., Ill., was considered in detail. The general arrangement and location of these mounds was clearly shown in a series of maps of the Long Lake, Bluff, Forest Park, St. Louis, Cahokia and other subgroups. It was shown that at the time these mounds were built, the Mississippi River probably was close to the Illinois bluffs, so that they were all originally on the west side of the stream, a fact which helps to explain their similarity. From their nature, it is evident that many years must have been required for construction and the archeological evidence points to their having been built by an agricultural people, quite different from the Cahokia Indians whom white men found here. Some views as to their possible use were considered. The plan of Monks', or better, Cahokia Mound was discussed and a number of early drawings and diagrams were thrown upon the screen. The known history of this mound was reviewed. Attention was called to the artistic possibilities of mounds and the agencies tending toward their destruction were emphasized. The speaker closed with a plea for the preservation of these wonderful relics of earlier ages.

G. O. James,
Secretary

SCIENCE

FRIDAY, MAY 15, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ISOSTASY AND THE SIZE AND SHAPE OF THE EARTH[1]

IT is the speaker's desire, in this paper, to touch briefly on some phases of geodesy which should be of general interest to the physicist.

Geodesy is one of the oldest sciences; probably second in this respect to astronomy alone. What is the extent of the earth in the horizontal plane, to what depth does it extend, and what is on the other side are questions which must have been asked by men of the earliest times. The history of geodesy will have to be passed over, for lack of time, although it would be interesting to follow the accumulation of data as to the shape and size of the earth.

Before one can study efficiently the great geophysical facts and comprehend them, he must know the shape and size of the earth with considerable accuracy. For some time before the end of the seventeenth century, it was taken for granted that the earth was a true sphere.

The announcement by Newton in 1687 of his theory that the earth was an oblate spheroid added much interest to the subject of its exact shape.

A meridional arc of about 8½ degrees, extending north and south of Paris, was measured by J. and D. Cassini between the years 1683 and 1716. The results of the first computations of this arc indicated that the length of the degree was less at the northern than at the southern end. This gave to the earth the shape of a prolate spheroid. A great controversy arose over

[1] Read on December 30, 1913, before Section B of the American Association for the Advancement of Science, at Atlanta, Ga.

the question as to whether the earth has the form of an oblate or prolate spheroid, and to settle it the French Academy sent expeditions to Peru in 1735 and to Lapland the following year to measure arcs near the equator and within the arctic circle. The result of these measurements confirmed the theory of the oblate spheroid. A revision of the computations of the Paris arc also showed that the northern degrees were the longer, thus confirming the results obtained from the work done in Peru and Lapland.

The first near approach to the size of the earth resulted from triangulation done in the last decades of the eighteenth century to connect the observatories of Paris and Greenwich and to determine the length of the earth's meridian quadrant. For the latter purpose an arc of the meridian of nearly ten degrees was measured in France. One ten-millionth of the resulting length was adopted as the standard of length (the meter). Any other length could have been selected as the standard, for the meter bears no such exact relation to a quadrant as later and more accurate data show.

Geodesists were very active during the nineteenth century and will be for some time to come, in making geodetic measurements to determine the mean figure of the earth with greater and greater degrees of accuracy. There comes a time, for any one given area, when it is useless to add more geodetic data for the purpose of obtaining a more exact mean figure, for there are constant or systematic errors present in the data, the effect of which is probably much greater than that of the accidental errors.

But there is much to be gained by extending geodetic surveys to new areas and especially to new continents. (By geodetic survey is meant, here, triangulation and connected astronomic stations.) All of the values of the earth's figure now available are the results of geodetic measurements in the northern hemisphere and, with the exception of India, the measurements have been confined to Europe and the United States. We may hope to get, before long, values for the figure of the earth from geodetic operations in South America and Africa, most of whose areas are below the equator, and Australia, all of which is in the southern hemisphere. It is believed that the mean figures resulting from accurate and extensive geodetic data in those continents will agree closely with the figures gotten from continents in the northern hemisphere. The geodetic surveys of the several nations on each continent should be connected and the reductions made on one spheroid and referred to a single initial position for each continent. Should this be done we shall be able eventually to compute a mean figure of the earth which will be of such great precision that it will satisfy the most exacting demands of science. The same spheroid and datum have already been adopted by Mexico, Canada and the United States.[2]

Coincident with the extension of geodetic surveys there will be carried on the computation of the geoid or the actual surface of the earth. This surface is probably so complex in shape that the work necessary to define it will have to be continued long after the satisfactory spheroid has been determined.

The geoid may be defined as that surface which coincides with the surface of the sea at rest. We can imagine an extension into the continents of an intricate network of sea-level canals. Then the surface of the oceans and the water in the canals would define the surface of the geoid. At some

[2] See news note in *Bulletin of the American Geographical Society*, August, 1913, page 614, on "The Adoption of the North American Datum."

points, probably not exactly at the sea shore, the mean figure of the earth—the spheroid—would intersect the actual sea surface, the geoid. Under the coastal plains the geoid would be slightly above the spheroid; while under great mountain ranges the geoid would be far above the spheroid, possibly as much as one hundred meters. Over the oceans the geoid would be under the spheroid surface by amounts varying directly with the depths of the water.

There is only one way to determine accurately the size of the earth, and that is by measurement on the continents of the lengths of arcs connecting points where the astronomic latitude and longitude have been determined. The measurements of such arcs may be direct, or they may be by means of triangulation. The earliest measurements were by the former method, but with the introduction of accurately graduated circles and the application of wires in the eye-pieces of telescopes, the indirect method came into general use.

At frequent intervals, in triangulation, the sides of some of the triangles in the scheme are accurately measured, in order to control the lengths. At the present time, this is done almost exclusively with nickel-steel (invar) tapes or wires. The probable accidental error of a measured length is seldom greater than about one part in one million. The constant error in such a measurement may be as great as one part in three hundred thousand. This accuracy is, however, far greater than that of the lengths of the triangle sides, as computed through the chain of triangles. The uncertainty of any one line between bases is about one part in one hundred thousand, on an average. A long arc, say one across a continent, can be measured with greater accuracy than that, for even the systematic and constant errors of the various sections of the arc would probably act as accidental errors, and the greater portion of their effect would be eliminated.

The observations for latitude, longitude and azimuth, or direction, are made on the stars; and in the most refined work a correction is made for the variation of the pole.

One might think that the determination of the figure and size of the earth is a very simple process, consisting merely of obtaining by astronomic observations the accurate angular distances between each two of several points on a meridian, and then measuring accurately the linear distances between them. Three such points being sufficient to obtain the equation of the curve formed by the intersection of the meridional plane and the spheroid, the shape and size of the earth would be known. This would be true if the spheroid and the geoid coincided throughout, but, as stated above, they do not do so. The plumb line to which all astronomic observations are referred is, at each point, normal to the geoid, which is a very irregular surface and, therefore, very many astronomic stations must be established and used. The greater part of each of the differences between the astronomic positions, as actually observed, and the theoretical positions, based on an adopted smooth mean surface, must be treated as an accidental error. These differences reach a maximum value of about twenty-five seconds of arc (within the area of the United States) which is nearly one half mile. In the island of Porto Rico, the relative deflection between two astronomic stations, one at Ponce and the other at San Juan, was 56 seconds of arc, about one mile.

The shape, but not the size, of the earth may be determined from the observed value of gravity at stations widely distributed in latitude. But here again a few stations are

not sufficient, for the value of gravity does not follow any known definite law, owing to the disturbing influences of masses above sea level and the deficiency of mass in the oceans.

Helmert derived a formula in 1901 from the observed values of gravity at about 400 selected stations. This formula gives theoretical values which will agree well, on an average, with the observed values, but for any one station the difference may be large, even after one of the values has been corrected for the elevation of the station above sea level.

Helmert's formula, in the Potsdam system, is

$$\gamma_0 = 978.030\,(1 + 0.005302\,\sin^2\phi - 0.000007\,\sin^2 2\phi)$$

in which γ_0, expressed in dynes, is the theoretical value at sea level in latitude ϕ.

It is evident that the difference between the theoretical and the observed values of gravity, and the deflections of the plumb line (which, as stated above, are the differences between the observed and the theoretical astronomic positions) are due to the disturbing influence of the topography and the effect of deviations from the normal densities in the earth's crust. The term "topography" is applied to the visible land masses and the deficiency of mass in the oceans. But when the attractions of the topography are applied as corrections, the differences may still be large, but of the opposite sign.

About sixty years ago Archdeacon Pratt of England arrived at the conclusion, from a study of the deflections in India, that there must be a deficiency of mass under the Himalayan Mountains and that the deficiency extended to a limited depth. The advancement of this theory marked an epoch in geodesy. From time to time, writers in different countries have elaborated on the mere statement of Pratt. But it was Hayford who gave this theory a quantitative expression when, as a member of the United States Coast and Geodetic Survey, he corrected the astronomic latitudes, longitudes and azimuths in the United States for the effect of topography and its negative equivalent, called "isostatic compensation," when making two determinations of the figure of the earth.[3]

A preliminary report on the application of the theory of isostasy to the study of the deflections in the United States was made by Messrs. Tittmann and Hayford to the Fifteenth General Conference of the International Geodetic Association, held at Budapest, Austria-Hungary, in 1906.[4]

Isostasy was also considered by Hayford and the writer in reducing the gravity stations in the United States.[5]

In order that a clear idea of isostasy[6] may be obtained, I shall quote Hayford:

> If the earth were composed of homogeneous material, its figure of equilibrium, under the influence of gravitation and its own rotation, would be an ellipsoid of revolution.
>
> The earth is composed of heterogeneous material which varies considerably in density. If this heterogeneous material were so arranged that its density at any point depended simply on the depth of that point below the surface, or, more accurately, if all the material lying at each equipotential surface (rotation considered) were of one density, a state of equilibrium would exist and there

[3] "The Figure of the Earth and Isostasy from Measurements in the United States," by John F. Hayford, U. S. Coast and Geodetic Survey, 1909; "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," by John F. Hayford, U. S. Coast and Geodetic Survey, 1910.

[4] "Geodetic Operations in the United States, 1903–06."

[5] "The Effect of Topography and Isostatic Compensation Upon the Intensity of Gravity," Spec. Pub. No. 10, U. S. Coast and Geodetic Survey, 1912, by John F. Hayford and William Bowie; same, second paper, by Wm. Bowie, 1912.

[6] The term *isostasy* was first proposed by E. C. Dutton. See *Transactions of the Philosophical Society of Washington, D. C.*, Vol. XI., pp. 51–64.

would be no tendency toward a rearrangement of masses.

If the heterogeneous material composing the earth were not arranged in this manner at the outset, the stresses produced by gravity would tend to bring about such an arrangement; but as the material is not a perfect fluid, as it possesses considerable viscosity, at least near the surface, the rearrangement will be imperfect. In the partial rearrangement some stresses will still remain, different portions of the same horizontal stratum may have somewhat different densities, and the actual surface of the earth will be a slight departure from the ellipsoid of revolution in the sense that above each region of deficient density there will be a bulge or bump on the ellipsoid, and above each region of excessive density there will be a hollow, relatively speaking. The bumps on this supposed earth will be the mountains, the plateaus, the continents; and the hollows will be the oceans. The excess of material represented by that portion of the continent which is above sea-level will be compensated for by a defect of density in the underlying material. The continents will be floated, so to speak, because they are composed of relatively light material; and, similarly, the floor of the ocean will, on this supposed earth, be depressed because it is composed of unusually dense material. This particular condition of approximate equilibrium has been given the name *isostasy.*

The adjustment of the material toward this condition, which is produced in nature by the stresses due to gravity, may be called the *isostatic adjustment.*

The compensation of the excess of matter at the surface (continents) by the defect of density below, and of surface defect of matter (oceans) by excess of density below, may be called the *isostatic compensation.*

Let the depth within which the isostatic compensation is complete be called the *depth of compensation.* At and below this depth the condition as to stress of any element of mass is isostatic; that is, any element of mass is subject to equal pressures from all directions as if it were a portion of a perfect fluid. Above this depth, on the other hand, each element of mass is subject in general to different pressures in different directions—to stresses which tend to distort and to move it.

In terms of masses, densities and volumes, the conditions above the depth of compensation may be expressed as follows: The mass in any prismatic column which has for its base a unit area of the horizontal surface which lies at the depth of compensation, for its edges vertical lines (lines of gravity) and for its upper limit the actual irregular surface of the earth (or the sea surface if the area in question is beneath the ocean) is the same as the mass in any other similar prismatic column having any other unit area of the same surface for its base. To make the illustration concrete, if the depth of compensation is 114 kilometers below sea level, any column extending down below sea level and having one square kilometer for its base has the same mass as any other such column. One such column, located under a mountainous region, may be three kilometers longer than another located under the sea coast. On the other hand, the solid portions of such a column under one of the deep parts of the ocean may be 5 kilometers shorter than the column at the coast. Yet, if isostatic compensation is complete at the depth of 114 kilometers, all three of these columns have the same mass. The water above the suboceanic column is understood to be included in this mass. The masses being equal and the lengths of the columns different, it follows that the mean density of the column beneath the mountainous region is three parts in 114 less than the mean density of the column under the sea coast. So, also, the mean density of the solid portion of the suboceanic column must be greater than the mean density of the seacoast column, the excess being somewhat less than five parts in 114 on account of the sea water being virtually a part of the column.

This relation of the masses in various columns, and consequently of the densities, follows from the requirement of the definition of the expression "depth of compensation," that, at that depth, each element of mass is subject to equal pressure from all directions. In order that this may be true the vertical pressures, due to gravity, on the various units of area at that depth must be the same.

If this condition of equal pressure, that is of equal superimposed masses, is fully satisfied at a given depth the compensation is said to be complete at that depth. If there is a variation from equality of superimposed masses the differences may be taken as a measure of the degree of incompleteness of the compensation.

The investigations of the deflections and of gravity referred to seem to prove rather conclusively that in the United States a condition of isostasy exists. How perfect it may be, and what is the area of the cross-

section and the depth of the unit columns which are supposed to have equal masses, have not yet been accurately determined.

The depth of compensation is probably somewhere between one hundred and ten and one hundred and thirty kilometers.

It is reasonably certain that the compensation is not always complete nor always uniformly distributed to the depth of compensation. (The above statements are, of course, intended to apply only to the area of the United States. Later on a brief statement will be made in regard to the rather limited results obtained in the other countries.) But the average conditions in the United States indicate a close approximation to those postulated.

The application of isostasy reduced considerably the apparent anomalies, or deflections, in the United States and Hayford was able to compute a figure of the earth which is generally considered one of the best, and probably the very best, now existing. His dimensions[7] are:

Equatorial radius, 6,378,388 ± 18 meters.
Polar semi-diameter, 6,356,909 meters.
Reciprocal of flattening, 297.0 ± 0.5.

The application of isostasy to the reduction of the gravity observations has reduced the average anomaly in the United States to 0.018 dyne, and at only one station is the anomaly greater than 0.060 dyne. It is, therefore, now possible to compute a value for gravity at any point in this country with an uncertainty of 0.018 dyne. By either of the previous two generally used methods of reduction, in which isostasy was not employed, the average anomaly in the United States was much greater.[8] The largest free air anomaly was 0.216 dyne and there were five other anomalies with values greater than 0.100 dyne. There were five Bouguer anomalies greater than 0.200 dyne and twenty-eight other anomalies greater than 0.100 dyne. It was found from the anomalies developed by the investigations of deflections and of gravity that there was no apparent relation between the topography and the size and sign of the anomalies nor between the anomalies and the areas of erosion or deposition. Some relations to the geological formation were developed.[9]

A severe test of the new method of reduction of gravity observations, with isostasy considered, was the determination of the flattening of the earth, from the stations in the United States alone. The resulting value is 1/298.4. This value agrees almost exactly with Helmert's value of 1/298.3 which resulted from a consideration of gravity stations widely scattered over the earth and with a great range in latitude. The anomalies by each of the older methods of reduction, in which isostasy is ignored, gave values which differed greatly from the generally accepted best values.

A brief statement of the method of making the gravity observations and of the accuracy attained will suffice. All of the stations in the United States used in the recent investigations had gravity determined by means of the quarter-meter invariable pendulum[10] which makes an oscillation in approximately one half second. It is a modification of the pendulums devised by

[7] See p. 54, "Supplemental Investigation in 1909 of the Figure of the Earth and Isostasy."

[8] The average free air anomaly was 0.028 dyne and the average value of the Bouguer anomaly was 0.063 dyne.

[9] See pp. 18–21 of "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" (second paper).

[10] This pendulum and its case are described in App. 1, Report of the Superintendent of the Coast and Geodetic Survey for 1894, by G. R. Putnam. The method of obtaining the flexure of the case and the support is described in App. 6 of the Report for 1910, by W. H. Burger.

von Sterneck of Austria and first used by him about the year 1887.

The method employed is to determine the period of oscillation at a base station and then at the new station and from the relation between the two periods the difference in gravity between the two stations is determined. This is called the differential or relative method of determining gravity. The difference in gravity may be obtained with an accuracy represented by a possible error of about ± 0.0018 dyne, on an average.

The base station for the United States is at the office of the Coast and Geodetic Survey in Washington, D. C. The value for it was determined by the relative method, from the station at Potsdam, Germany, at which the absolute gravity had been determined from a long series of observations made with reversible pendulums.

It is difficult to determine the absolute gravity with a great precision, as is shown by the determination of the difference in gravity at Vienna and Potsdam, by the relative method. Each of these stations had its absolute value determined by many years of observations and each value was considered to be correct by an amount represented by a probable error of only a few thousandths of a dyne. The relative determination showed an error between them of 0.016 dyne.

Of course, the same constant error which may be present in the base station of a system will also be present at each station of that system determined by the relative method. Potsdam is now generally used as the base station for the world, although the values are also occasionally referred to the Vienna station. The values in the two systems will differ by 0.016 dyne.

A comparatively small error in the value of gravity at the base station of the system does not appreciably affect the flattening of the earth, derived from the gravity data of the system.

The investigations made in the Coast and Geodetic Survey show that, on an average, the gravity anomalies and the unaccounted for residuals of the deflections of the vertical are small for the United States. They also show that the area of the United States as a whole is practically in a state of perfect isostatic equilibrium. But there are many places where the gravity anomalies and the deflections indicate departures from the state of equilibrium. It is very important that additional data may be gotten which will permit of a determination of the degree of deviation from the perfect state and of the horizontal extent of the affected regions.

In one of the illustrations[11] of the second report on the gravity investigations, which shows by contours the Hayford anomalies, the evidence would lead one to believe that the causes of the largest anomalies are confined to small areas. For instance, there is an anomaly at Washington of + 0.037 dyne, while at Baltimore, only 40 miles distant, the anomaly is — 0.011 dyne. At Seattle, the anomaly is — 0.093 dyne, while at Olympia it is + 0.033 dyne, and the distance between the two places is only about 50 miles. There are other cases of decided differences in the anomalies in short distances, and no doubt more will develop when additional gravity stations have been established.

The data shown in the illustration referred to lead to the conclusion that there is no extensive area in the United States which is very much under or over compensated. This is equivalent to saying that

[11] No. 2 of the "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" (second paper).

there is no large area which departs much from the perfect isostatic state.

It has been held by some[12] that the crust of the earth within the area of the United States is at all places in a state of perfect isostasy and that the gravity anomalies are caused by the investigators' erroneous distribution of the compensating deficiency of mass. This, no doubt, is true to a certain extent, but no rational distribution will account for the larger anomalies except upon the theory that there are local actual departures from the perfect isostatic state.

Earlier in this paper it was stated that there were developed some relations between the size and sign of the gravity anomalies and the geological formation. The stations established on the oldest rocks show an average anomaly of $+0.024$ dyne, that is they indicate too much mass in the earth's crust, while the most recent formations and the effusive and intrusive rocks give average negative anomalies which vary from -0.005 to -0.015 dyne. These show deficiencies of mass. It is not clear whether these anomalies are due to local deviations from the adopted mean surface density of the earth (2.67) or to actual departures from a state of complete isostasy.

The following table shows a summary of the gravity anomalies arranged in the several geological groups.

A stratum of material 100 feet in thickness, and of indefinite extent will cause an attraction of 0.0030 dyne. Therefore, the average anomaly 0.019 dyne would correspond to a stratum 630 feet in thickness. The average elevation of the United States is about 2,500 feet. Therefore, the isostatic compensation may be considered

[12] "Interpretation of Anomalies of Gravity," by Grove Karl Gilbert, Part C of Professional Paper 85, Contributions to General Geology, 1913, U. S. Geological Survey.

Geologic Formation	Number of Stations			Mean Anomaly	
	All	With plus Anomalies	With Minus Anomalies	With Regard to Sign	Without Regard to Sign
Archeozoic and Paleozoic	9	9	0	+0.024	0.024
Paleozoic	32	13	19	− .004	.019
Mesozoic	20	9	11	+ .001	.015
Cenozoic	33	15	17	− .007	.021
Effusive	8	2	6	− .005	.016
Intrusive	5	1	4	− .016	.018
Unclassified	16	10	6	+ .008	.020
All stations	123	59	63	− .001	.019

to be about 75 per cent. complete on an average for stations in this country. But the average gravity anomaly with regard to sign is 0.000 dyne, or nearly so, therefore it is safe to conclude that the area of the United States as a whole is in a state of perfect isostasy.

A more exact knowledge of the precise location with respect to depth of the compensating deficiency or excess of mass would be of very great interest and value. This is particularly true in the case of the areas where there are stations with large gravity anomalies. A preliminary study by the Survey will be made of this question in the near future. For this purpose the value of gravity and the deflections of the vertical in the vicinity of the anomalous areas will be used jointly. The preliminary studies may show whether much is to be expected from future investigations after much more gravity and deflection data are available.

An attempt will be made shortly to correct the deflections for the effect of the excesses and deficiencies of mass as shown by the gravity anomalies. It is possible that some of the unaccounted for portion of the deflections may be eliminated. The ideal condition would be to have only such residuals of the deflections as are caused by an error in the adopted figure of the earth, for then a new figure might be com-

puted which would have far greater accuracy than any now existing.

The theory of isostasy has been applied in several other countries in the reduction of deflections and of gravity, but not to any great extent. In Switzerland the new method makes the observed and computed gravity agree more closely than do other methods which do not consider isostasy. In India the theory of isostasy has been applied and the preliminary results indicate that that country is not so completely compensated as is the United States.[13] The complete reductions have not been made. Their results will be of world-wide interest and importance.

The reduction, by the new method, of all the gravity stations of the world should be made in order that additional data may be available for studying the distribution of the materials in the earth's crust in different parts of the world, and because the results would make it possible to compute a better shape of the earth. There is no necessity for delaying this reduction. Mr. Tittmann, the superintendent of the Coast and Geodetic Survey, in his report to the conference, at Hamburg, in 1912, of the International Geodetic Association, stated:

> It is hoped that the International Geodetic Association in the near future may reduce all the available gravity stations of the world by this method, for it is reasonably certain that a value for the flattening of very great precision could be deduced from the results.

While each of the great nations and many of the smaller ones are making gravimetric surveys, yet there are many sections of the globe which have very few or no gravity stations. Some great institutions may, in the not distant future, see the importance of a world-wide gravimetric survey and start out parties to make one.

The geodesist is in great need to-day of an apparatus for measuring gravity accurately on a vessel at sea. We have no accurate values over the vast ocean areas. Dr. Hecker's gravity determinations at sea, with the boiling point thermometer apparatus, are subject to uncertainties as large as the largest new method anomalies of gravity in the United States, that is, between 0.050 dyne and 0.100 dyne. Gravity at sea should have actual errors not greater than about 0.010 dyne.

Some of the geological questions may or may not be answered by a consideration of isostasy,[14] but with isostasy an established fact, at least for large areas, the problems should not be as difficult as when various theories were held as to the degree of rigidity of the earth's crust.

One of the problems is as to the manner in which the earth's surface assumed an irregular shape. This is probably the most difficult one to answer. Of the theories proposed by a number of great men of science, none seems to be entirely satisfying. The theory of the unequal contraction of the outer layers of the earth during the change from the liquid to the solid state sounds reasonable until we consider that the thickness of the crust which could be affected is only about 70 miles, according to the theory of isostasy. There are extensive areas on land which average several miles in height. Also the great deeps in the oceans for considerable areas have average depths as great as four miles.

[13] In a letter from Col. Burrard, published in *Nature*, May 8, 1913, he makes the statement: "Both the pendulum and plumb-line observers find the attraction of the Himalayas to be largely compensated, whilst the Windhyan Mountains are not compensated at all." It should be noted that the Himalayan range is about 4 miles in height, and the Windhyan range only 0.6 mile in height.

[14] See "The Relations of Isostasy to Geodesy, Geophysics and Geology," by J. F. Hayford, SCIENCE, N. S., Vol. XXXIII., No. 841, pages 199–208, February 10, 1911.

It is impossible that the same materials could have densities differing by six parts in seventy, or nine per cent., due simply to unequal contraction from loss of heat. It is conceivable that the chemical elements of the earth's crust were the same everywhere before solidification, but they must have formed different chemical compounds in order to have had such different densities as must obtain in order to have the earth's crust in a state of equilibrium. The materials in the crust below the depth of 70 miles are assumed in the investigations to be in hydrostatic equilibrium and consequently they should have the same density in any layer at a given depth.

A theory, held by some, would make the depth of compensation a function of the elevation of the surface. The mountains would, according to this theory, have long roots of low density extending far down into the plastic materials, which are supposed to be below the seventy-mile depth. The investigations of the Coast and Geodetic Survey do not seem to substantiate this theory. If it were true we should have all of the crust under the continent of the same density down to a certain, unknown depth at which the plastic substrata began. The compensation would take place below that depth and it would consist in protuberances extending down into the plastic matter. The interior of the earth must be solid, but yielding to long-continued stress differences. Just how the depression of the sea bottoms is to be accounted for under this theory, the writer does not recall having heard. The crust there would probably have to be very thin.

A short article by Dr. P. G. Nutting,[15] suggested to the writer a possible cause of part of the elevation of the continents and the depression of the ocean beds. Let us assume that the surface of the earth, formerly at a high temperature, had cooled to a point below that of boiling water and that the surface was not level. Then the aqueous vapor would condense and fall in great quantities as rain and remain on the earth and flow to the lowest areas. This added mass would tend to produce an isostatic adjustment which would cause an undertow of material from the lower areas to the more elevated ones, with a resulting further depression of the low areas and elevation of the higher ones. How much effect this could have had is difficult or impossible to estimate. Of course, if there had been no irregularities in the earth's surface before the precipitation, the water would have covered the earth to a uniform depth.

The correct answer to another question would be of great value to several branches of science. The earth's crust, at least that part of it within the United States, may now be considered in a state of perfect isostatic equilibrium. But what was its condition in past geologic ages? It seems reasonable to suppose that the earth's crust was in the past in a state of isostatic equilibrium at least as perfect as at present, if it is assumed that the earth's crust is gradually getting cooler. With a high temperature the materials of the crust would have been more plastic than at present and should have yielded more readily to stress differences.

If we have now and always have had a condition of equilibrium in the earth's crust, can the recorded movements be explained on the isostatic theory?

The deflections and the pendulum observations show that the areas from which great masses of materials have been eroded are in equilibrium; also that areas within

[15] "Isostasy, Oceanic Precipitation and the Formation of Mountain Systems," SCIENCE, October 6, 1911.

which there have been great depositions are in isostatic equilibrium. We, therefore, must conclude that the mountains have been maintained for long ages at approximately the same elevation by an undertow of material toward them, while the areas of deposition maintain their depth in spite of the added material by a sinking due to the undertow from the crust under such areas. Consequently, the continent may be considered as not being leveled off as a result of erosion, but as kept at approximately the same general elevation.

While an isostatic adjustment by means of a transposition of material may account for the normal condition under the areas of erosion and deposition, it does not account for the great elevation, into mountains and plateaus, of rock which was once under the ocean. Evidently there must have been a change in the density, under such areas, and an expansion of the materials in the earth's crust to the extent indicated by the height of the topography above the sea. This change was not due to a mere expansion from change of temperature, as a bar would expand. The expansion of the crust must have been due to chemical or physical changes which made the elements present form compounds with densities differing from what they had been previously. What could cause such rearrangement as to change the density by several parts in one hundred is a problem for the geophysicist and geologist.

The fact that material which was once under the sea now forms a mountain range seems to disprove the "root of the mountain" theory of compensation. It is difficult or impossible to see how the crust with its surface at or below sea level (supposedly in isostatic equilibrium) could, in addition to expanding to form the mountains, also decrease its density in that portion far below the average depth of compensation (122 kilometers). As a matter of fact, the deflections and the gravity observations indicate that the compensation is not deep down in the crust, but in general within the depth stated above.

The movements noted in the exposed earth's materials have been slow and were in most cases due to stress differences which were below the rupturing point of the rock. There has been much slow yielding, without fracture, to long-continued stress differences. The isostatic adjustment of the earth's materials in the upper crust after or during erosion might cause many of the movements that have been recorded in the strata.

In conclusion, the immediate work which the geodesists should perform is to reduce all the existing gravity stations of the world by the same method which should be based on a rational theory of isostasy. As opportunity permits, a gravimetric survey should be extended to new regions and especially to oceanic islands. And as soon as an apparatus is designed which may be used successfully on a vessel, an extensive gravimetric survey of the oceans should follow.

William Bowie
U. S. Coast and Geodetic Survey

SAFEGUARDING THE HEALTH OF COLLEGE STUDENTS[1]

Attention has frequently been called to the fact that many educational institutions fail to make adequate provision for safeguarding the health of their students. These criticisms find expression most often in connection with the report of the injury or death of a student who has been allowed to participate in athletics without proper medical supervision; or when some serious sanitary fault causes, or contributes to, an epidemic among the stu-

[1] Based upon paper presented at Fourth International Congress on School of Hygiene, Buffalo, 1913.

dents; or there is unfavorable comment when some promising young student breaks down in course or shortly after graduation as a result of overwork or bad hygienic habits.

Many cases even more deserving of unfavorable criticism in which the student suffers avoidable physical damage and loss of time and money never come to light. These may be due to physical tendencies and handicaps that should have been discovered and warned against on examination, or to sicknesses that could have been avoided by better sanitation and control of living conditions. Four years of life in a college or university should mean for the average boy or girl a distinct gain in physical efficiency and in habits of sane, hygienic living instead of the opposite of these things, as is too often the case.

It is of course true that to-day nearly every institution of college rank is trying to make, or intends to make, some provision for protecting and promoting the health of its students. There has been a very marked change for the better in this respect during the past few years, and a wider recognition of the practical importance of measures that tend to keep the student in good health. Too often, however, the provision made consists merely of a gymnasium and facilities for competitive athletics, the use of which as well as the time and energy of the teachers are mainly limited to that small percentage of the student body who are candidates for the teams; and in connection with which there is no well-considered plan for bringing these and other agencies in the institution into a harmonious relationship for effective work in promoting health and efficiency.

It is not probable that any system of health supervision, however carefully devised and administered, can entirely prevent the occurrence of sickness or accident among the students. There can be no question, however, that much more should be done than is being done or even considered, in the majority of colleges and universities in the country, to limit the amount of preventable sickness and to increase the working efficiency of the students; nor can there be any question of the real and permanent value of such preventive and educational work for both the individual and the community of which he becomes a part. The formulation of an adequate plan for health supervision must be based upon a consideration of the factors affecting student health in the college community. Such a study will suggest the division of these factors into two groups. In the first group will fall those factors that may be classed as "environmental," *e. g.*,

1. General sanitary condition of the neighborhood such as drainage, sewage disposal, breeding places for flies and mosquitoes.

2. Food and water supply in commons and boarding houses.

3. Sanitary conditions of rooms in dormitories and lodging houses as regards baths, toilets, janitor service and general surroundings.

4. Provision for advice and treatment in dispensary or infirmary in case of sickness.

5. Opportunities for exercise and recreation.

The second group will include the "individual factors," such as:

1. Physical characteristics and tendencies to weakness.

2. Knowledge and practise of the essentials of personal hygiene.

3. Habits of exercise and recreation.

This grouping serves at Princeton University as a logical basis for the division of responsibility for the supervision of student health between two closely allied bodies: The sanitary committee and the department of hygiene and physical education.

The sanitary committee is composed of six men appointed from the board of trustees and the university faculty, one of whom is a member of the department of hygiene and physical education. It has the responsibility for the administration of those factors which I have called "environmental." It maintains a close supervision over the administration of the commons and the infirmary; it employs the university physician, and has periodical inspections made of those lodging and boarding houses used by students for whom—about 15 per cent.—there is at present no provision on

the campus. It is also advisory to the board of trustees on such questions as:

1. Plans for modern sewage disposal plant.

2. The installation of a milk-pasteurizing plant in the commons.

3. Plans for a new infirmary, and a study of the sanitary features of plans for new buildings.

The administration of the second group of factors, those relating to the individual himself, falls to the department of hygiene and physical education. This department is organized and equipped to fulfill the following functions:

1. To conduct a regular academic course in hygiene, which is required of all freshmen one hour a week throughout the year.

2. To make thorough medical examination of all freshman at the beginning and the end of the year, and of all candidates for competitive teams at the beginning of each season, or more frequently in special cases.

3. To conduct classes in physical education, which is required of all freshmen three periods a week throughout the year.

4. To provide opportunities for exercise and the necessary instructions in voluntary work by upper classmen.

5. To encourage participation in intramural games and competitions by those who are not candidates for the regular university teams.

6. To stimulate the development of habits of hygienic living and of outdoor exercise and recreation among the whole student body.

Since the health interests of the university are closely bound up with those of the town, a natural and harmonious relationship has grown up between these two parts of the community for the promotion of the interests of general health. The active bodies in this work are the university sanitary committee and the borough board of health with its health officer. This board is composed of seven men, three of whom are members of the university. The president of the board is also chairman of the university sanitary committee, thus providing an opportunity for the closest cooperation between the two bodies. The effectiveness of this relationship is shown in the measures that are put in force by joint action to improve the sanitary conditions in the community at commencement time, when there are many reunion headquarters temporarily established throughout the town; and at the time of the big games when there is an influx of from 20,000 to 30,000 people with the consequent strain upon sanitary provisions. The university contributes towards the salary of the health officer, so his services are available, under the direction of the sanitary committee, for the inspection of boarding and lodging houses occupied by students; for the periodical examination of the milk supplied to the commons and of the water in the university swimming pool; and for the technical supervision of the sanitary condition of grounds and buildings. The close relationship existing among these three bodies, the board of health, the sanitary committee, and the department of hygiene, makes possible an effective cooperation which results in an economical and efficient administration of the health problems of the entire community.

A university in a small town like Princeton which has a population aside from the university community of about 5,000 presents a simple problem from the point of view of health protection as compared with an institution located in a large city. It may be impossible to work out such an organization as this that we have been considering in every college town; but the general principle of establishing some comprehensive and effective plan of health administration should be put into effect in every large institution. A brief discussion of some of the essential phases of the plan as outlined may be of use in giving a clearer view of the work.

The supervision of the Princeton University infirmary is a function of the sanitary committee. The infirmary is in charge of an infirmarian, who is assisted by the necessary nursing and housekeeping force. The building contains fifteen beds and was built nearly twenty years ago. An isolation ward of about the same size was added later. A well-equipped dispensary adds greatly to the usefulness of the infirmary. Plans for a new in-

firmary are practically completed, as the present building is sometimes taxed to its utmost. The university physician is employed by the sanitary committee and attends the infirmary three hours daily, during the early morning and the late afternoon. Students are admitted upon his certificate and attended by him. A student may be attended by a physician from the town who is approved by the sanitary committee; and physicians and surgeons may be called in consultation if necessary.

Students are charged $7 a year infirmary fees, which cover all necessary expenses during their stay in the infirmary. In contagious cases, or cases requiring special nursing the expense of the additional nurse is charged to the student. As board bills are charged to all students on their regular term bills the infirmary is credited with the amount of board the student would ordinarily pay during such time he may be confined to the infirmary. During the past year there were 400 bed cases, and about 4,500 dispensary calls. These figures may seem large for a student body of only 1,500, but much of the service in the dispensary, and even among the bed cases is in a measure preventive. For example, a boy with an incipient cold may be put to bed over Saturday and Sunday, and so a more serious illness and a further loss of time prevented.

In case a student is confined to his room by sickness that fact is reported to the college office before 10:30 by the janitor or the lodging house mistress, together with a statement whether or not a physician has been called. This early report gives an opportunity for word to be sent to the university physician, so that he can visit the student before noon if he has not secured medical attendance. No sick student is allowed to remain in his room in a dormitory more than a day. He is promptly taken to the infirmary, where he is given medical attention and nurses' care.

The inspection of the lodging and boarding houses is done regularly and a report is made on a form provided for the purpose. The points investigated include among others a statement as to the kind of house, the kind of room, the provisions for heating, lighting and ventilation, the bath-room provisions, and the general character and tone of the place and people. In the case of boarding houses additional information is gained regarding the sanitary conditions of the dining-room, the kitchen, the refrigerator, care in garbage disposal, and notes on the general surroundings, such as the proximity of stables, chicken yards, exposed garbage, etc. Repeated inspections are made at irregular intervals during the year. Any defects are reported to the secretary of the sanitary committee who serves notice upon the owners of the premises. If the recommendations are not complied with promptly, the students are ordered out of the premises. The knowledge that such action will be taken by the university authorities and the fact that all payments for board and rent are made through the university treasurer's office, have had the effect of forcing the owners to keep the premises in proper condition.

A comprehensive physical examination is conducted by the department of hygiene and physical education. Special emphasis is laid upon the determination of the functional condition of the eyes, ears, nose, throat and the vital organs. The information so obtained serves as a basis for advice as to special exercises if needed. Advantage is taken of the opportunity to discuss with each individual the various practises and habits that affect his mental and physical efficiency. A follow-up scheme has been devised which makes it possible to keep in touch with special cases at regular intervals during the year and to cases referred to the home physician.

The course in personal hygiene deals with the fundamentals of health and physical efficiency; the influence of diet, exercise, bathing, etc.; the effects of personal habits, as the use of tobacco and alcohol; sex hygiene; and a study of the more common infectious diseases, their nature, cause, methods of transmission and prevention. Emphasis is laid upon the practical points of daily life, upon inducing the students to adopt a hygienic method of living, and upon the fact that health is in a very large measure subject to control.

A good deal of emphasis is placed upon the effort to promote the formation of habits of outdoor exercise and recreation among the upper classmen. This is done by organizing classes for voluntary work in various branches of physical education and by encouraging the organization of teams for athletic competition. In the development of these intra-mural athletic activities, advantage is taken of every natural student division as a basis for the organization of teams, with the result that there were during the past year 145 organized teams playing regular schedules for the championships of various groups; and throughout the year there were more than 1,300 men, counting the duplications on various teams during the different seasons, and not counting those who were on the various varsity squads, who took part in these contests. Competitions were conducted in swimming, water polo, relay racing, rowing, basket ball and baseball. The above statement does not include the large number of students who take part in individual contests in boxing, wrestling, tennis, golf and swimming.

This plan of guarding and promoting student health has been developed under the stimulus of the conviction that an educational institution has a real responsibility for the physical welfare of its students; that health is an educational factor of prime importance; that a student not entirely well is working under a handicap and is lowering the efficiency of the institution; and that a healthy body is one of the first essentials of clear thinking, clean living and efficient citizenship.

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PRINCETON UNIVERSITY

THE GOVERNMENT OF LEARNED SOCIETIES

IN connection with the work of a committee of the American Psychological Association I wrote a year ago to the secretaries of all the "learned societies" listed in the World Almanac asking how their officers were elected and whether the method was satisfactory. With very great courtesy almost every secretary answered my first question (though one or two copies of constitutions failed to reach me), and most of them answered the second. The result is that I find myself with an amount of material which it seems well worth while to put together in print.

The sixty-eight "learned societies" here listed can be divided according to their method of electing officers into some nine groups, as follows.

Group A.—In the following associations officers are elected by the governing board.

American Academy of Political and Social Science. Officers are elected by (9) directors, one third of whom are elected annually to serve three years.

American Antiquarian Society.

American Association for the Advancement of Science. Officers are elected from fellows by general committee, which consists of council plus one fellow or member elected by each section. Council consists of certain present and past officers, fellows elected by sections and affiliated societies, and nine fellows elected by the council. Permanent secretary, secretaries of sections and treasurer hold office for five years.

Archæological Institute of America. Officers are elected by council, which is composed of general officers and delegates from local affiliated societies. Executive committee is partly ex-officio, partly elected by council at annual meeting.

American Numismatic Society. Council elects officers. Members of council are nominated from the floor and elected by ballot.

National Association for the Study and Prevention of Tuberculosis. Officers are elected annually by board of sixty directors on nomination of committee appointed by chair. One fifth of directors are elected at each annual meeting.

National Geographic Society. Managers elect officers. Eight of the twenty-four managers are elected at each annual meeting to serve three years. A majority of the votes cast is necessary for election.

New York Zoological Society. Officers and executive committee are elected by managers. Executive committee appoints a nominating

committee which prepares and posts nominations to replace the outgoing class of board of managers. Members vote on these at annual meeting.

Group B.—In the following associations nominations for office are made by the governing board at the annual meeting. Usually the rule permits other nominations to be made from the floor, though they are not often made. It is not always clear whether or not the official nominations include positions on the governing board itself.

American Association of Obstetricians and Gynecologists.

American Association of Pathologists and Bacteriologists. Rule includes all nominations. Council member serves seven years.

American Bar Association. Officers nominated by general council, which consists of one member from each state.

American Geographical Society of New York. Rule includes all nominations, but nine or more fellows can also nominate.

American Ophthalmological Society.

American Pediatric Society.

American Proctologic Society.

American Psychological Association. Rule includes nominations for council.

American Therapeutic Society.

Society of Chemical Industry, New York Section. Committee nominates chairman, secretary and treasurer. Ten or more members can nominate ordinary member of committee. If there are not enough nominations committee completes list and there is no election. Five members of committee retire annually, three of whom shall be those who have made the fewest attendances at committee meetings.

Southern Medical Association.

The advantages claimed for this method of close control by the governing board are that it is less dangerous than off-hand nominations from the floor, facilitates business, has worked perfectly, allows meetings to be devoted to science exclusively. Eight secretaries commented on it favorably. In a ninth association a considerable number of members felt that it was unnecessarily oligarchical. Another objection is that it has occasionally been embarrassing to have a small governing body called upon to choose between two or more of its own members for the presidency. This objection would not hold in the case of an association whose governing board is composed largely of ex-presidents.

Group C.—In the three following associations nominations for office are made by a nominating committee which is itself a more or less permanent body. The election takes place at annual meeting.

American Gynecological Society. Nominating committee consists of all ex-presidents at meeting. Two nominations are made for each office.

Society for the Promotion of Engineering Education. Nominating committee consists of the past presidents and the seven elective members of the council retiring the following year, but the president may add enough to bring members present up to five.

American Philological Association. Each year the chair nominates one new member of the nominating committee to serve five years.

It is claimed on behalf of this method that it ensures continuity and causes less unfavorable comment than random nominations from the floor.

D.—In the American Society of Civil Engineers the membership is divided into seven geographical districts, each of which is represented by two members of the nominating committee, one elected each year to serve two years, and the five latest past presidents who are alive. The secretary is appointed by the board. The method appears to be satisfactory, though it is possible under it for men to be elected to the nominating committee who are not familiar with the work of the association.

Group E.—In the following associations a nominating committee is appointed annually by the governing body. Elections are at annual meeting.

American Historical Association. It is said that years ago this association tried and abandoned something like a preferential primary.

American Library Association. Nominating committee appointed by executive board from persons not on board. Board adopts report

and prints names on the official ballot. Others may be added on petition, with consent of nominee. Council is partly self-perpetuating.

Group F.—In the following associations a nominating committee is appointed annually by the chair, though in the cases indicated it is simply said that it is "appointed." The committee reports, and officers are elected at the meeting.

American Academy of Medicine. "Appointed."

American Association of Anatomists. "Appointed." Officers elected for two years, secretary for four. Executive committee of eleven.

American Climatological Association. Usually consists of ex-presidents.

American Dialect Society. Nominating committee is "appointed" at the annual meeting, receives suggestions as to who is willing to serve, and reports in a few minutes.

American Economic Association. "Appointed." Usually consists of ex-presidents if enough are present.

American Fisheries Society.

American Forestry Association. "Appointed."

American-Irish Historical Society.

American-Jewish Historical Society.

American Laryngological Association.

American Laryngological, Rhinological and Otological Society.

American Medico-Psychological Association.

American Oriental Society.

American Otological Society. Nominations by business committee of three appointed by president for that meeting.

American Roentgen Ray Society. "Nominees are then voted upon by the Society" (two tickets?). It has been recently arranged in the interest of democracy that the new member of the executive committee be elected by ballot.

American Society of Naturalists.

American Sociological Society. Executive committee is partly elected, partly made up of former presidents. Practise has been to keep the same group of officers for a period of two years.

American Statistical Association.

American Surgical Association.

The secretaries of every one of these nineteen associations commented on their method of electing officers. One of them said no fault had ever been found with the method, though ambitious people were sometimes disappointed in the results. A second said that for twenty years the method had been found satisfactory, but that during the last year it had been claimed that such nominations may reflect the views of an extremely limited portion of the association instead of voicing the general desire. The remaining seventeen said without qualification that it worked well: "the ticket is always elected," "the secretary casts a ballot and there is never a grumble." The following statement, however, may not seem very satisfactory to extreme democrats: "The association is usually very harmonious at its annual meetings, and a small group of people have for some years practically prepared the slate. I think this is practically the custom with all similar organizations, and I believe it rarely happens that there is any controversy in regard to the matter."

Group G.—In the four following associations the nominating committee is chosen more democratically. Officers are elected at annual meeting.

In the American Microscopical Society and in the American Orthopedic Association the nominating committee is elected at a business meeting.

In the American Urological Association members of the nominating committee are selected by and from the various members of the several Sections present at the annual meeting.

In the Medical Association of the Southwest the nominating committee is composed of five members from each of the five states composing the association.

All four of these associations seem to be satisfied with their methods.

Group H.—In the following associations officers are elected by members present at the annual meeting, but there appears to be no nominating committee.

In the National Academy of Sciences officers

are elected by vote of the members present at the annual meeting. There is nothing in the constitution about their nomination.

In the American Dermatological Association officers are nominated on the first day of the annual meeting and elected on the second.

In the American Institute of Architects officers are elected by ballot of the delegates at the annual convention.

In the American Medical Association nominations are from the floor. Majority of votes cast is necessary for election.

In the American Entomological Society officers are nominated at the meeting before the annual meeting. The nominations are not restricted in any way and there is no nominating committee.

In the Actuarial Society of America officers are elected at the annual meeting without any nominations being made. Previous to the meeting, however, there is a straw ballot for members of the council, every fellow voting for two candidates for each vacancy. The result of this straw ballot is announced before the election, but it does not bind anybody.

In the American Ornithologists' Union an informal ballot is taken at the annual meeting and its result is announced before the first formal ballot is taken.

In the American Institute of Homeopathy any ten members at annual meeting can nominate. If no one gets a majority at first election there is a second vote confined to two highest candidates. It has been ruled that members nominated for an office can not withdraw their names.

In the American Association of Public Accountants officers are elected by delegates and fellows at large at the annual convention. Secretary is elected annually by trustees.

In the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge officers are elected on the first Friday of January and the polls are open between the hours of two and five in the afternoon. Nominations must be made at the stated meeting next previous to the day of election; but if there should occur a failure of qualified candidates so nominated others not so nominated may be elected.

Group I.—In all the following associations the business of nominating and electing officers is conducted largely through the mails.

In the Geological Society of America the council prepares the regular ticket, and this is mailed to the members at least nine months before the annual meeting. Any five members may forward other nominations to the secretary. Such nominations are printed together with the names of the nominators as special tickets. The regular and special tickets are then mailed to the fellows at least twenty-five days in advance of the annual meeting. Balloting is then done by the use of two envelopes, of which one, the inner envelope, bears a legend indicating that it is a ballot; the outer envelope bears the voter's name, and before it is opened the secretary looks up the records to see whether the man is entitled to vote or not.

In the American Mathematical Society the council nominates at the October meeting through a committee usually composed of ex-presidents and ex-vice-presidents. Nominations are printed on a ballot with blank spaces for other names, and mailed to members, who may vote by mail or in person at the December meeting.

In the American Nature Study Society the council nominates one or more candidates for each office and members vote by mail or in person.

In the American Public Health Association the council nominates officers and submits ticket to the whole association for their vote. Council represents different states and federal departments.

In the American Society of Mechanical Engineers the president appoints a nominating committee, and any group of twenty or more members entitled to vote may constitute themselves a special nominating committee. Names of nominees and their nominators are mailed to members on an official ballot, together with an inner and an outer envelope, as with the geologists. A simple plurality of votes elects. Method is said to be perfectly satisfactory.

In the American Institute of Electrical Engineers the method pursued up to 1911 was as follows. Nominating blanks were mailed to the entire membership. After the forms

were returned and canvassed the directors prepared a "directors' ticket." This ticket, together with a statement of the votes received by all the candidates who had received not less than 3 per cent. of the entire number of votes cast, was issued to the membership. Members could vote for any one whose name appeared on this blank. The directors' ticket was always elected, as the vote against any one upon it would be scattering. For geographical considerations the directors did not always select the candidates who had received the largest number of nomination votes. The principal objections to this method appear in the *Proceedings* for January, 1912. They are these. There is no official way by which a group of members who desire to recommend a certain candidate can make their wishes known to the entire membership. Members can not usually tell whether a man they think of nominating is willing to accept. The scattering vote is increasing each year. The only way to suggest candidates is by circular letters, which become a nuisance. Not more than 20 per cent. of the members fill out nomination forms; so that a man with a very small vote can get on the directors' ticket and be elected. The new rule provides that on petition of fifty members a man's name may be printed on the nominating blank as a candidate for nomination. This results in a larger and more concentrated vote.

In 1912 the American Institute of Mining Engineers was practically changing its entire management. Under the old rule there was a board of directors and a council. Nominations for members of the council could be sent to the secretary, who mailed to the members a list of all nominations for each office so received, together with the names of persons ineligible for election to each office; and if the council or a committee thereof should have recommended any nomination, such recommendation was sent also. The new method recommended by a special committee resembles that of the American Society of Civil Engineers.

In the American Chemical Society members mail preference for president and four councilors. Council elects president from the four having the largest number of nominating ballots. For council the highest eight are considered nominated, and names mailed to members. Usual double envelopes for secrecy. Nine directors are elected by letter ballot of the entire (102) council. The directors are now the governing body, as council has grown too large.

In the Astronomical and Astrophysical Society of America members were nominated by mail and the three with the largest number of nominating votes were voted upon by members present at annual meeting. In case of a plurality of names in third place all were included in list to be voted upon. Plurality elected. The method had not proved entirely satisfactory, and a committee had been appointed to consider its revision.

In the Botanical Society of America individual members nominate by mail. The council then sees that there is at least one nomination for every office. Members vote by mail. Plurality elects. A recent rule empowers the secretary to eliminate the names of all nominees but the three receiving the highest number of nominating votes. Yet sometimes ten or a dozen receive the same number and have to appear on the final ballot mailed to members. Another possible objection to this method is that a few members of the association in one of the large universities can easily put a set of names in nomination by concentrating upon them when other nominating votes are scattered.

The conclusions which I am disposed to draw from the material at my disposal are as follows: A governing board of some kind is indispensable, and it is wise to follow the usual practise of electing a given proportion of its members every year for a term of years. If there is much work to be done by the secretary, he should be nominated either by a permanent nominating committee or by the governing board. If he accepts remuneration for his services he should be nominated or appointed by the board.

It is not usually wise to try to elect members of the governing board or other officers

without the aid of the board or some other committee, and it is distinctly unwise to do so if nominations are made through the mails.

If the board or a special committee is to act at all on nominations it seems better for it to nominate in the first place than to act on haphazard nominations afterwards. If the board itself nominates there is no reason why it should not send ample notice of its ticket to all the members of the association. In the absence of such notice it is not usually desirable that the board should nominate its own future members; for reasonable continuity in the management of an association is sufficiently insured by changing only a part of the board at a time, and the action of a series of nominating committees appointed from year to year by retiring presidents is less likely to cause continued irritation to a section of the association than the corresponding action of a practically self-perpetuating board.

If an official slate is unsatisfactory there is more chance to break it under a rule allowing other nominations to be made by groups of a certain size than under one allowing them to be made by single individuals.

No plan of election by members present at the annual meeting has been shown to be better than the common one of allowing the retiring president to appoint a nominating committee.

If an association exists for the sake of its meetings and does not attempt in any way to regulate the practise of a profession, it is questionable how far its machinery should be complicated for the sake of giving those who do not attend the meetings a voice in its management.

H. Austin Aikins
Western Reserve University

STANFORD UNIVERSITY

The trustees of Stanford University have increased the president's budget for the academic year of 1914–15 by approximately $75,000 over that of the present year, which was about $475,000. Of the increase, $33,370 is for additions to the salaries of the present members of the faculty, and $20,000 for an addition to the usual allotment for departmental equipment. Ten thousand dollars of the increase to the budget is for the maintenance of the university's memorial church, which upon the completion of rebuilding since the earthquake has been placed under the president's direction. The salary increases have been apportioned among the ranks in the teaching force as follows: professors, $11,950; associate professors, $6,350; assistant professors, $10,700; instructors, $4,370. The trustees also announce a number of new buildings to be added to the university plant. These include, for the medical school in San Francisco, the remodeling of the main hospital building and the addition immediately of a new wing practically doubling the capacity of that building, and later the erection of a new women's building; and on the campus at Palo Alto a new library building, a new gymnasium for men and a new museum building. The library building, preliminary plans for which are being drawn, based upon suggestions by Librarian G. T. Clark, who has recently visited new college libraries in various parts of the country, will with the new museum form the front of a new quadrangle approximately of the same size as the present main quadrangle of the university, which is not quite 900 feet long, and will lie just east of it. The museum will not be undertaken for two or three years. The present museum is about a quarter of a mile from the main quadrangle, and President Branner in his inaugural address, urging the educational value of beauty, declared that the art collections here are practically inaccessible to the average student. In this same connection, and following the president's suggestion in the same address, the trustees are working out a comprehensive scheme of landscape gardening for the beautification of the university grounds. The salary and equipment increases and the new building announcements are in fulfilment of a statement published a year ago by the Stanford trustees, in which they declared that the resources of the university will in the future justify an increase in the annual allotment for academic

purposes, and that with the collaboration of Chancellor Jordan and President Branner, they had determined to build up the present departments of university work to the highest point of efficiency before entering new fields. The salary increases, it is announced, are the first of several to be made with the intention of raising the pay of the teaching force to a level somewhat nearer than it has been to that reached by the cost of living.

FOREIGN STUDENTS AT AMERICAN COLLEGES AND UNIVERSITIES

THERE were 4,222 foreign students in attendance at colleges and universities in the United States in the year 1913, according to figures just compiled at the United States Bureau of Education. This is an increase of 577 in two years. These students are not concentrated at the larger and better known institutions, as might be expected, but are distributed over 275 different colleges, universities and schools of technology. The number given includes only regular students of college or graduate grade; if students enrolled in preparatory departments, short-term courses, summer schools and independent professional schools were included, the total would be very much larger.

Canada has the largest representation—653 students. China and Japan are not far behind—there were 594 Chinese students and 336 from Japan attending colleges in the United States in 1913. Of the other Oriental or Asiatic peoples, India is represented by 162 students; Turkey by 143; Korea by 13; Persia by 21, and Siam by 13.

Latin-America is strongly represented. Cuba sends 209; Costa Rica, 29; Guatemala, 15; Honduras, 12; Nicaragua, 18; Panama, 28, and Salvador, 19. Mexico heads the list with 223 students. From South America, Argentine sends 43 students; Brazil, 118; Bolivia, 3; Chile, 12; Colombia, 37; Ecuador, 16; Paraguay, 2; Peru, 25; Uruguay, 2, and Venezuela, 7.

Abundance of higher education opportunities in the British Isles and on the continent of Europe has not prevented nearly 800 European students from coming to America to go to college. Great Britain and Ireland are represented by 212 students, and Germany, herself the meca of the studious, sends 122. The others, in order of numbers, are: Russia, 124; France, 45; Sweden, 41; Italy, 38; Austria-Hungary, 34; Switzerland, 29; Norway, 26; Greece, 22; Spain, 20; Netherlands, 19; Bulgaria, 15; Roumania, 6; Belgium, 4; Portugal, 3; Montenegro, 1.

Even Australia and Africa have students at colleges in the United States. There are 56 students from New Zealand. Africa is represented by 15 from Egypt; 2 from Liberia, and 44 from South Africa.

From American possessions 434 students came to college in the United States; 108 from Hawaii; 215 from Porto Rico, and 111 from the Philippine Islands.

THE GEORGE WASHINGTON MEMORIAL

THE jury of award of the George Washington Memorial Association have given first honors to the architectural firm of Tracy and Swartwout, New York.

The members of the committee, Mr. Philip Sawyer, Mr. Charles A. Platt and Mr. Walter Cook, met for the consideration of the award, on May 2, but deferred their decision until May 4 when they came to the conclusion that of the thirteen competing architects, the plans rendered by Messrs. Tracy and Swartwout were the most satisfactory. The selected drawings will now be presented to the National Commission of Fine Arts, and, with their approval, the association will give the architects charge of the construction of the building. The first award is $1,500, but each competing architect who has submitted plans in accordance with the specifications will receive an honorarium of $500.

Tracy and Swartwout's drawings depict a fine colonial building with pillared front, and square ground plan. The main feature is the great auditorium seating 6,000 people, which is artistically arranged in the form of an ellipse, with the stage at one end, and a deep balcony encircling the whole. The site of the building is to be in that part of the

Washington Mall known as Armory Square. All the drawings entered in the competition are now on exhibition in the National Museum.

This building, to be known as the George Washington Memorial, and to be administered by the regents of the Smithsonian Institution, was authorized by an Act of Congress passed March 4, 1913. The work of construction must be begun before the fourth of March, 1915, or the authorization by congress for the use of the above site will lapse. It is further provided that the work of construction can not be commenced until the sum of $1,000,000 is raised by the association, and although Mrs. Henry F. Dimock, president of the association, and chairman of the building committee, has secured a good part of this sum, much still remains to be raised.

SCIENTIFIC NOTES AND NEWS

The Willard Gibbs medal will be presented by the Chicago section of the American Chemical Society to Dr. Ira Remsen on the evening of May 15.

Former students of Professor John Henry Comstock have raised a fund, to be known as the Comstock Memorial Library Fund, which is to be presented to Cornell University for a permanent memorial of Professor Comstock's forty years of distinguished service as instructor and professor of entomology. He is to retire from active teaching as a member of the faculty next June, at the age of sixty-five. The ceremony of presentation will take place on June 13.

The Academy of Natural Sciences of Philadelphia has elected as correspondents the following: Frank M. Chapman, Edmund Heller, Edgar A. Mearns, Gerrit S. Miller, Charles W. Richmond, Marie Curie, Shibussaburo Kitasato, Charles T. Ramsden and N. Charles Rothschild. The same institution has appointed as delegates to the Nineteenth International Congress of Americanists, Charles D. Walcott and H. Newell Wardle.

At the annual meeting of the New Orleans Academy of Sciences, held at Tulane University on March 17, William Benjamin Gregory, professor of experimental engineering in Tulane University, was elected president of the academy for the ensuing year.

Mr. James A. Barr has been appointed director of congresses for the Panama Pacific Exposition.

Professor Elwood Mead has reconsidered the acceptance of a professorship of rural instutions in the University of California, and will remain chief engineer of the commission of rivers and water supply of the state of Victoria.

The United States Department of Agriculture has established an office in the bureau of chemistry for the purpose of promoting a closer and more cordial cooperation among the city, state and federal food and drug officials of the country in the enforcement of the food and drug laws. Mr. J. S. Abbott, for nearly seven years dairy and food commissioner of Texas, was appointed to this office and began active service on April 3, 1914.

The Howard Taylor Ricketts prize for undergraduate research work, awarded on May 3, each year, as a memorial of the death of Howard Taylor Ricketts while engaged in the investigation of typhus fever in Mexico City, is this year awarded to Julian Herman Lewis.

The Hunterian Society's Medal, offered annually for the best essay by a general practitioner, has been awarded to Dr. Basil T. Parsons-Smith, who took for his subject, "The Intermittent Pulse."

The Helen Schaeffer Huff memorial research fellowship at Bryn Mawr College has been awarded to Miss Vernette Lois Gibbons, who will continue her investigation of the potentials of the metals in non-aqueous solutions.

The trustees of Clemson College have appropriated $300 for an investigation of the limestone and marl deposits of South Carolina and their value for agricultural purposes. The work will be in charge of Dr.

F. H. H. Calhoun, professor of geology and mineralogy.

Dr. L. J. Henderson, assistant professor of biological chemistry, has been appointed the professor from Harvard University for the second half of the year 1914–15 under the interchange agreement between Harvard University and the four western colleges—Beloit, Grinnell, Knox and Colorado.

Professor Percy E. Raymond, of Harvard University, has left for an expedition under a grant from the Shaler Memorial fund to explore regions about the Baltic.

Professor G. D. Harris, of Cornell University, will leave Ithaca early in June in a thirty-foot motor boat to take an inland trip down the Atlantic coast for the purpose of studying the geological formations on the route and to add to the university's collection of geological specimens. He will be accompanied by six or eight graduate students who are specializing in paleontology.

Professor J. H. Leuba, of Bryn Mawr College, will be absent next year on sabbatical leave. His work will be taken by Professor E. Wilm, now at Wells College and by Dr. Chester E. Kellogg.

The University of Pennsylvania Chapters of Phi Beta Kappa and Sigma Xi held their annual joint meeting on May 1, when an address, entitled "The Whole Man," was made by Professor R. M. Wenley, of the University of Michigan.

On the evening of May 4, Professor C. J. Keyser delivered an address before the Phi Beta Kappa Alumni in New York on "Science and Religion: the Rational and the Superrational."

Dr. L. A. Bauer gave the following course of illustrated lectures at the Johns Hopkins University:

May 4, "The General Magnetic Survey of the Earth. I. The Chief Phenomena and Instruments of Investigation used in Ocean and Inland Work."

May 5, "The General Magnetic Survey of the Earth. II. The Results and Bearings of Magnetic Observations."

May 6, "The General Characteristics of the Magnetic Fields of the Earth and of the Sun and Results of Analyses."

May 7, "Résumé and General Theories."

Professor Gustav Killian (Berlin), who will deliver the Semon Lecture at the house of the Royal Society of Medicine, on May 28, has selected for his subject, "Suspension Laryngoscopy and Its Practical Use."

The Romanes lecture at Oxford University will be delivered on June 10, by Sir Joseph John Thomson, professor of experimental physics at Cambridge. The subject is "The Atomic Theory."

A conference under the auspices of the Société des Amis de l'Université de Paris has been held to consider the subject of the fourth centenary of Andreas Vesalius, the great anatomist, who was born in Brussels in 1514. The plan is to erect a monument to his memory on the island of Zante where he died in 1564, next August, under the auspices of the Belgian government.

Professor Newton Horace Winchell, formerly state geologist of Minnesota and professor of mineralogy and geology at the University of Minnesota, died on May 3, aged seventy-five years.

Professor Eduard Suess died on April 26 of pneumonia at the age of eighty-three. Until his eightieth birthday he had been president of the Vienna Academy of Sciences. Professor Suess was not only the dean of modern geologists, but a Liberal politician of the old school, whose parliamentary activity was largely directed against the organized forces of professional obscurantism.

Dr. Otto May, honorary professor of agriculture at the Technical School at Munich, has died at the age of eighty-one years.

The Swiss Society of Neurology has called an International Congress of Neurology, Psychiatry and Psychology to be held at Berne, September 7–12, 1914. An organization committee and various international committees have been appointed.

The committee having in charge the Samuel D. Gross prize, valued at $1,500, of the

Philadelphia Academy of Surgery, announces essays in competition for the prize will be received until January 1, 1915. The essays, which must be written by a single author in the English language, should be sent to the "Trustees of the Samuel D. Gross Prize of the Philadelphia Academy of Surgery, care of the College of Physicians, Philadelphia."

THE board of governors of the General Memorial Hospital, New York City, have voted to enter into an affiliation with Cornell University Medical College for the conduct of the General Memorial Hospital as an institution for the study and treatment of cancer and allied diseases. This affiliation is rendered possible by the gift of a large sum from Dr. James Douglas, which, in addition to the present endowment of the institution will render the hospital largely independent of an income from other sources. The grounds for an affiliation are to be found in the facts: (1) That this institution was originally created for the purpose of cancer treatment and research, but the original funds were insufficient to enable it to enter this field exclusively. (2) The board of governors feel with Dr. Douglas that the study of cancer and the development of the new means of its treatment can be successfully carried out only through the combination of the efforts of laboratory workers specially trained in this field and clinical surgeons. The laboratory staff maintained by the college and the Huntington Fund is available for this work and the medical board of the hospital will be composed of such men, together with the surgeons, as are specially interested in cancer treatment and research. All forms of tumors and malignant diseases as well as cancer are to be included in the scope of the work. The institution duplicates on a large scale other hospitals which have been created in this country and abroad for similar purposes, the best known examples of which are Middlesex Hospital in London and the Samaritan Hospital of the University of Heidelberg.

As a result of recent experiments conducted by a member of the advisory committee on the Langley Aerodynamical Laboratory of the Smithsonian Institution, a new form of flying-boat hull has been evolved, which appears to have decided advantages over the types now in use. These experiments were made by Naval Constructor H. C. Richardson, U. S. N., chairman of the subcommittee on hydromechanics in relation to aeronautics of the Langley Laboratory, at the model basin of the Washington Navy Yard. Several model hulls were used, some of which represented the different types of naval hulls now in use, one a model of the Curtiss pontoon, and others obtained through changes and improvements in standard forms. They were one ninth full size, except the Curtiss model which was one fourth actual size, and were tested both on the surface of the water and submerged one foot. In his report Naval Constructor Richardson has shown by diagrams and tables the advantages and disadvantages of the various types, as well as the plan, side and end views of five models. Tests were made on the surface of the water for the resistances at "displacements corresponding to speeds," and other tests were made submerged as a means of determining their total head resistance in air, and of ascertaining an approximate coefficient of fineness of form. Further experiments are under way for the determination of the stream line flow about submerged models, as a means of improving the form, and to otherwise perfect the standard type most advantageous for all purposes. Comparisons of the model results and the actual performances of full-sized machines show that a fair analogy exists, confirming the behavior of the models under experiment. Actual experiments with a full sized machine shows the hollow V section very desirable because of the good landing qualities, as landings which would otherwise stress the machine badly have been made without any shock. The report of the experiments forms Publication No. 2253 of the Smithsonian Miscellaneous Collections.

UNIVERSITY AND EDUCATIONAL NEWS

THE gifts to Oberlin College for various purposes during the last months amount to nearly $190,000, apportioned as follows: For campus

improvement, $25,000; for a new art building, $125,000; for a new organ in Finney Memorial Chapel, $25,000; subscriptions toward the new athletic field, $14,300. A large number of gifts, mostly anonymous, go to make up the $125,000 for the new art building.

DR. BEVERLY THOMAS GALLOWAY, assistant secretary of the Department of Agriculture and previously chief of the Bureau of Plant Industry, has been appointed by the trustees of Cornell University to be director of the New York State College of Agriculture. Dr. Galloway takes the place which was vacated by the resignation of Professor L. H. Bailey and which has been filled this year by Professor W. A. Stocking as acting director.

AT the University of Missouri, Dr. I. F. Lewis, of the University of Wisconsin, has been appointed professor of botany, and Professor E. J. McCaustland, of the University of Washington, dean of the engineering faculty and director of the engineering experiment station.

WALTER COLLINS O'KANE has been elected professor of zoology and entomology at the Ohio State University. He graduated from the university in the class of 1897 and has been connected with the New Hampshire station for the past four years.

AT Cornell University, George A. Works has been elected professor of rural education in the college of agriculture, and David Lumsden assistant professor of floriculture.

DR. GERTRUDE KAM, demonstrator in psychology at Bryn Mawr College, has been made an associate.

DR. DOUGLAS MCINTOSH, associate professor in McGill University, has been appointed associate professor of chemistry and acting head of the department in the newly established University of British Columbia.

DISCUSSION AND CORRESPONDENCE

A NOTE ON THE ACCESSORY CHROMOSOMES OF MAN

IN two recent publications in which Montgomery's and my own observations on the accessory chromosomes in man (negro) have been mentioned, the phraseology of the authors would lead any one who had not read the original papers to the conclusion that there was a decided discrepancy in our results, whereas just the reverse is true. Thus Morgan in his book, "Heredity and Sex," after remarking on my account of the accessories says (p. 245):

> Montgomery has also studied the same problem, but his account while confirming the number, is in disagreement in regard to the accessory.

And again Kornhauser, in his "A Comparative Study of the Chromosomes in the Spermatogenesis of *Euchenopa Binotata*, etc.," *Arch. f. Zellforsch.*, Bd. XII., No. 2, speaking of cases in which "the x-element is in the form of two chromosomes in the male" as found by Wilson in *Syromastes*, continues (p. 280):

> Guyer ('10) has reported a similar condition in the spermatogenesis of man. This case, however, would seem to need confirmation, for both Gutherz ('12) and Montgomery ('12) have, in the main, been unable to support Guyor's contention.

This last is certainly a surprising statement for any one to make who, has read Montgomery's paper, as the following excerpts from his "Human Spermatogenesis, Spermatocytes and Spermiogenesis, A Study in Inheritance," *Jour. Acad. Nat. Sci. Phila.*, Vol. XV., 2d Series, 1912, well attests. Speaking of the chromosomes of the primary spermatocytes he says (p. 8):

> I can confirm Guyer's conclusion that there are 12, of which 10 are bivalent gemini, each dividing in both maturation mitoses, and 2 univalent allosomes (accessory chromosomes) which divide only once in the two maturation mitoses. Guyer's view is therefore probably correct that the number in the spermatogonia must be 22 and not 24 as reasoned by Duesberg.

There is a slight discrepancy in Montgomery's and my account of the subsequent behavior of the accessories but even here we agree in the main, for speaking of the ordinary behavior of the accessories Montgomery continues (p. 9):

> This is the usual condition and the one discovered by Guyer.

As a matter of fact, the discrepancy lies in the fact that, in addition to this usual behavior, Montgomery records certain atypical cases as follows: five cases in which the members of the double accessory go to opposite poles; ten cases in which the smaller member of the pair divides, one half going with its customary associate to one pole, the other half going alone to the opposite pole; five cases in which the larger member divides; three cases in which both accessories divide. On looking over my material again since the appearance of this and other papers on human spermatogenesis, and also after the examination of some new negro material received in the meantime, I still feel convinced that conditions for the male negro are essentially as I originally described them.

The most decided differences in accounts of human spermatogenesis are those which obtain between the findings of Montgomery and myself on the one hand and von Winiwarter on the other. The latter finds 47 ordinary and one accessory in the male. It must be borne in mind, however, that Montgomery and I worked on the tissues of negroes and von Winiwarter on those of a white man. I am at present engaged in a study of material from two different white men and although not yet ready to make a detailed statement I can say with assurance that the number of chromosomes is considerably in excess of those found in my negro material.

Michael F. Guyer
The University of Wisconsin,
April 3, 1914

MORAL AND RELIGIOUS TRAINING IN A STATE UNIVERSITY

To the Editor of Science: Chancellor Frank Strong's paper in Science of November 21, on "Some Educational Problems in Kansas," mentions as one of the great problems confronting education in that state "moral and religious training," saying:

> If any were misled years ago into the belief that intellectual training provided sufficient safeguards and moral standards, certainly our experience the last decade must have disillusioned him.

The "if" is a saving word in that statement, to any who might be disposed to disagree with the chancellor, but it still seems a fair question to ask, How otherwise than through the intellect is education of any kind to be conveyed? Also, it would seem to be not altogether out of place to inquire as to exactly what is meant by the terms "moral" and "religious," not to obtrude a discussion of religion in a publication devoted to a quite different purpose, but to make clear the intentions and plans of those, like Dr. Strong, who insist that education is incomplete and dangerous without the application of certain remedies which they have to offer. A few are interested in religion, but all of us in education.

If the meaning of the terms refers to acts of worship, which in their nature are emotional and suggestive rather than instructive, such as prayers, the reading of scriptures and singing of hymns, it is a popular understanding that it is the function of the church to attend to such things, not the high schools, colleges and universities, for in such institutions Jews, Catholics, Greeks, Turks, Chinese, Japanese, Mormons and agnostics often mingle, all with such divergent beliefs touching religion that creedal or sectarian teaching and forms would be wholly out of place. Such students place themselves under instruction to learn the truths of science and history and to study art, literature and languages, not to be proselytized. Like the purchaser of a commodity in trade, they come to buy what they think they need, not what some one else wants to force on them, and if they are forced, in order to get the instruction needed, to take other kinds which are repugnant to their religious convictions, it becomes tyranny.

As to morals, there is no dispute among civilized peoples generally in all parts of the world. Honesty, truthfulness, mercy, forgiveness, unselfishness, restraint of passions, honoring parents—"these and a few others," as Buckle truly said, "have been known for thousands of years, and not one jot or tittle has been added to them by all the sermons, homilies and text-books which moralists and theologians have been able to produce." There could be no objection, of course, to their being taught in the schools if it seemed necessary—

taught directly, not by the subterfuge that they could only follow from religious acts, therefore it is necessary to teach religion—but if made a part of the curriculum I should like to know how large a place our professors would be likely to assign them. Would a three years' course seem too short, or a four year, perhaps, too long to teach a boy that honesty and good habits are right, and the opposite are wrong? Or would such things be assumed to have been taught during childhood in the only proper place—at the mother's knee?

Since Chancellor Strong lays emphasis on the statements, that "after all . . . ours is a Christian civilization," and "Historical Christianity is the basis of our whole life, and we as a nation shall stand or fall with it," he must then mean by the "moral and religious problem confronting education in Kansas as elsewhere" the question of how to bring about the teaching of Christianity by compulsion and at national or state expense, an attempt as out of joint with the times as with the purpose of the founders of the country, that church and state should be forever separate.

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SCIENTIFIC BOOKS

THE EASTMAN-ZITTEL PALEONTOLOGY

The appearance of a second and very much enlarged edition of Dr. Eastman's English version of Zittel's "Paleontology" (Volume 1, Invertebrates) may be accepted not only as an acknowledgment of the usefulness of the work but also as a response to a growing interest in the study of ancient life. It is very probable that the justification for the revision of this expensive and elaborate work comes chiefly from the American demand, and, if this is true, the demand may perhaps be counted among the first fruits of the efforts made by The Paleontological Society to encourage and widen a deeper concern in that field. While this statement has reasonable worth, yet the fact stands out clearly that the Eastman-Zittel "Paleontology" is by far the best, practically the only satisfactory general guidebook and compendium of the science. Even the first edition was a more useful book than the German original because of its greater detail and closer analyses, though we have been given to believe the innovations in classification introduced by the first collaborators were not altogether acceptable to the lamented and distinguished author, Professor Zittel. But in a science which covers the whole field of life, progress must be rapid; new encyclopedias soon become old as new lands are explored and old ones more closely scrutinized, and old philosophies and classifications give way under the burden of new knowledge. No one person could to-day successfully do what Zittel did—write a book covering the entire field of ancient life. Versatile as he was in many departments of paleontology, competent to expound as he did the structures of sponges and dinosaurs, to-day such diverse efforts would be looked upon with a grave hesitancy by students generally, that would assuredly weaken the voice of authority.

So, in this new book, there is a divided authority, even more pronounced than in the first edition, and the American author, Dr. Eastman, modestly withholds his own name from any acknowledged responsible share in the separate chapters, which leaves us to infer that he did all the work the others did not do (no small amount when one analyzes the allotments) and of course did the real work on the rationale of all the combined chapters.

In giving to Science a notice of this work, it seems appropriate to restrict it essentially to the new material, either in the form of accretions from later discoveries or of revised classifications, and to present these new features succinctly and with precision the reviewer has asked most of the contributors to briefly state the differences between the old and the new in the chapters with which they have been severally charged.

In the 1899, or first, American edition there were 12 collaborators; in this edition of 14 years later there are 17 coworkers, and but three names of the first list remain on the last: Dr. Dall, Professor Schuchert, Mr. Clarke. The increase in the number speaks of greater refinement of knowledge as well as of wider activity of research in the later years.

The Foraminifera (Joseph A. Cushman) have been given a fuller introductory discussion and the classification is essentially made over. Though without additional illustration, the chapter is essentially new.

The Porifera have been amplified (by the author-editor) with additions on the Hoxactinellids, and it is interesting to note the elevation of *Receptaculites* and *Ischadites* from a footnote to a place in the text body.

Regarding the Anthozoa, which have been revised by T. Wayland Vaughan, the editor remarks that the classification adopted, "although perhaps as good as any available, is tentative in character." Among the Tetracoralla there are few changes; in the Hexacoralla Dr. Vaughan has added some important text and illustrations in tho general discussion and in the classification are some noteworthy alterations. We notice the family Fungidæ and its allies created into a suborder Fungida, and the omission of the Madreporidæ (on the assumption that they do not occur fossil). The extensive array of tabulate corals or favositids is no longer an "appendix to the Hexacoralla" as in the first edition, but more conservatively expressed as an "appendix to the Anthozoa." Into this group *Chætetes* is admitted, but *Monticulipora, Fistulipora* and their allies are put back again among the Bryozoa.

The Graptolitoidea (R. Ruedemann) formerly standing in an "Appendix to the Campanulariæ," are likewise more broadly considered as a "Class or Subclass of the Hydromedusæ." This chapter has been considerably enlarged in text and illustration and the taxonomy rectified by substituting for the oddly incongruous *subordinal* terms of the early edition Monoprionidæ, Diprionidæ, etc., the classification wrought out in the author's well-known memoir on these organisms.

The Vermes have been amplified by the introduction of Walcott's recent remarkable discoveries in the Cambrian.

A number of collaborators have revised the Echinodermata: Frank Springer, the Cystoidea, Blastoidea and Paleozoic Crinoidea; Mr. Springer, with A. H. Clark, the Post-paleozoic Crinoidea; H. L. Clark, the Asteroidea and Holothuroidea, and R. T. Jackson, the Echinoidea. These are distinguished authorities and the amendments they have made must be regarded as well up to the present state of knowledge of these groups. In Mr. Springer's part of the work there is an enlargement of about nineteen pages, and in the classification of the Crinoidea the two authors have rearranged the divisions in better harmony with their geological succession and their recognized structural relation. A striking feature is the inclusion of the stalked pentacrinites and the unstalked comatulids in one family and the union of the genera *Marsupites* and *Uintacrinus* with the comatulids.

A singular and rather confusing thing in this connection is an incongruity in classification which must have escaped the author's eye. The family Pentacrinidæ is divided into three sections, one of which, the "comatulids," is divided into three "tribes." The second of these tribes is made to contain many genera grouped into a large number of different *families.*

Mr. H. L. Clark has given an entirely new classification of the Asterozoa and has amplified the chapter on the Holothurians, including even the Cambrian species discovered by Walcott, though he has elsewhere gone on record as doubting the echinoderm nature of these fossils.

The Echinoidea have been brought up to the stage of Dr. Jackson's exhaustive knowledge of the group, expressed in his recent elaborate treatise on these bodies. New cuts are introduced, some showing structural characters of the group as a whole and others representative Paleozoic echini. In the classification the arrangement is in natural phylogenetic sequence based on a comparative study of development and adult structures.

In the Bryozoa by R. S. Bassler, the Monticuliporoids, which in the last edition were made to appear in the "double and daring act" of both Bryozoa and Anthozoa, are now excluded from the latter, as just observed, because of the recent demonstration of their early budding phases. A revised classification

is presented of the Cyclostomata, with 5 suborders, one of them, "Ceramoporoidea," being new; a natural division given of the *Trepostomata* and the most recent work on the *Cheilostomata* is included.

In the Brachiopoda (Charles Schuchert) the form of the chapter and the general principles of the classification have been retained, but the latter has not only been elaborated to such completeness as to assemble all outstanding generic divisions of which the later years have added no small number, but have been illuminated by the expression of phylogenetic lines and terminals. This procedure has made necessary the introduction of a good many new divisions of supergeneric value, but it conveys a conception of developmental relationships never before so well expressed.

The chapters on the Pelecypoda, Gastropoda and Pteropoda have undergone no material changes except for the inclusion of new generic terms (W. H. Dall), but in the Cephalopoda by J. Perrin Smith there are notable expansions in both matter and illustration. For some reason the Nautiloidea have been left pretty much as they stood before, though a great deal of work has been done on the group in the last 14 years by Germans and Americans; but the Ammonoidea have been amplified by many new cuts of Carbonic, Permic and Triassic forms. It will surprise many students of this group to find Hyatt's classification, adopted in the first edition, quite entirely cast out in favor of the German taxonomy as expressed by Zittel and of late years amplified by European students and by Dr. Smith, himself a collaborator with Professor Hyatt. The present classification is in a way a trial adjustment of the old and the new.

The Trilobites have been revised by P. E. Raymond, who has enlarged the generic list from 55 genera in 14 families, as in the first edition, to 126 genera in 28 families; a statement which indicates the persistent and growing interest in this group of fossils. The principles of the classification are those followed by Beecher in the first edition. The reviser has incorporated his own interpretation of many old and rather vaguely defined names, such as some of Corda's and Angelin's, with a generous number of new generic conceptions based upon his own researches.

The Branchiopoda and Ostracoda have been brought up to date by R. S. Bassler with a considerable number of new figures. The Cirripedia and Malacostraca (by William T. Calman; Phyllocarida by J. M. Clarke) are not materially unlike their earlier presentation, while the Arachnida-Merostomata (J. M. Clarke) have been considerably revised with some substitution of old for new illustration, especially of restorations based on the researches recently published by Clarke and Ruedemann. The Arachnida-Embolobranchiata (Alexander Petrunkevitch) are brought into line with recent discoveries with some additional illustration, and the Myriapoda stand very much as they were left in the old edition.

Mr. Anton Handlirsch's chapter on the Insecta is a wholly new and original document of thrice the text matter and twice the illustration of the former edition. The general discussion and the classification are so entirely unlike the original that even a trace of the latter is hard to find. It may well be regarded as the best present expression of information regarding this group.

JOHN M. CLARKE

School Health Administration. By LOUIS W. RAPEER, New York Training School for Teachers. Published by Teachers College, Columbia University, New York City.

Part I., pp. 1–70, gives an outline of national health problems in their relations to the school. Part II., pp. 71–294, summarizes the findings of an intensive study which the author has made of the methods and results of school medical service in twenty-five typical cities in the eastern states. Part III., pp. 295–358, offers a tentative standard plan for the administration of school health work.

The book is the fruit of several years of first-hand investigation of the methods of medical inspection as it is actually carried on. The author goes behind the glowing accounts

found in the reports of superintendents and school doctors, and measures the efficiency of the systems by the application of a few common-sense statistics and the principles of scientific management. He shows in a most convincing way the inefficiency of some of the methods in vogue and offers a plan which ought to be taken as a model until experience shall have given us something better.

The book reveals a broad grasp of the larger significance of educational hygiene, and points clearly to the many dangers of misplaced emphasis in this new but promising field of child welfare. It should be studied especially by school superintendents, school doctors, school nurses and social welfare workers.

The appearance of the book is somewhat marred by a rather unattractive make-up; and the author's style, while vigorous and interesting, is not always as direct and clear as one would like.

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INVESTIGATIONS IN THE ATLANTIC OCEAN[1]

MEASUREMENTS of the temperature and salinity of the surface water of the Atlantic Ocean have for many years been carried out by route steamers and other vessels traversing these waters. The necessity of systematically conducted investigations, of both hydrographic and biological character, not only at the surface, but also in deep water, is pointed out. Such a systematic investigation of the whole of the Atlantic Ocean must be regarded as one of the most important scientific and practical tasks of the future.

Pettersson and Drechsel were intrusted by the Central Bureau of the International Study of the Sea, with the task of drawing up a memorandum as to the ways and means by which an international reconnaissance of the Atlantic Ocean could be organized in the near future. These gentlemen have conferred with many of the leading authorities on oceanography in other countries.

The authors concluded, as the result of such conferences, that the matter could not be farthered by the ordinary discussions and resolutions on the part of learned societies. The only way was to seize the first favorable opportunity of commencing the investigations. The first trans-Atlantic hydrographical investigation would probably have to be made from ships in the naval service. Coastal seas could be studied only by real investigation steamers, specially fitted for fishery-biological work.

The following program was drawn up:

I. Investigation of Coastal Seas;

II. Transatlantic Investigation.

These investigations are to be carried out simultaneously, since in this way a more comprehensive view can be obtained of the actual condition of the Atlantic Ocean in summer and winter. After the general survey has been made, special investigations of individual questions can be taken up. To complete such investigations it is important that the countries bordering on the Atlantic Ocean should cooperate. Great Britain and the United States have already cooperated, and France and Canada should also participate. For the investigation of the coastal seas, the following program is suggested.

(*a*) Quarterly cruises to be made to the *northeastern part of the Atlantic water system*, from Iceland to Spitzbergen, including the North Sea, the Skagerack, the Cattegat and the Baltic.

(*b*) In reference to the Iceland-Faeroe-Wyville Thomson ridge, the Rockall channel and the mouth of the Channel, it is to be hoped that the former will be investigated by the Scottish, Danish and Norwegian commissions, and the mouth of the Channel by the Irish Fishery Department.

(*c*) In the sea east and west of Greenland the determination of the conditions with regard to ice is of prime importance. The Danish Meteorological Institute has already done good work in this field.

(*d*) We do not possess a single hydrographical section through the Labrador current, and

[1] Abstract of a report by Petterson and Drechsel. The address of Pettersson is: Professor Otto Pettersson, Holma i Brastad, Sweden.

yet this current plays such a prominent part in the water circulation of the Atlantic. Some observations are already being made in connection with the shipping interests.

(*e*) In reference to the Coastal Sea of North America, discussed under caption (*e*), it is pointed out that hydrographic observations should be obtained over the area extending 600 miles south 30° east of St. Johns, Newfoundland, returning directly to the Flemish Cape and thence to St. Johns. Also at other points on the "Grand Banks" and neighboring fishing grounds. It is also recommended that quarterly cruises be carried out in the months of February, May, August and November from Cape Lookout to the Bermudas and thence to Florida. Monthly observations should be made on section between southern Florida and Nassau, and between southern Florida and Havana; also in the Atlantic Ocean north of Cape Hatteras.

(*f*) The Newfoundland Bank and adjacent waters are both scientifically and practically the most interesting area for study, since it is here that we have the conflict between the Gulf Stream and the Labrador current. The bearing of the results obtained on the fishery question would be very direct and very important. The fact that the fishery on the Grand Banks is seasonal would indicate an annual periodicity in the hydrographical conditions. Ways and means are not yet worked out for connecting the study of the Newfoundland Banks with a future, general study of the North Atlantic Ocean.

(*g*) The Portuguese coast and the Plateau of the Azores can be investigated largely by the Portuguese, who are very much interested in the problem. With the permission of the Portuguese government, two cruisers can make quarterly cruises into these regions.

Transatlantic lines of investigation can be carried out only by direct government aid. To secure this cooperation on the part of the different governments, it is necessary to have a well-arranged program, and to select some "favorable opportunity" for carrying it out. The following program and opportunity are suggested.

The Program

The basin of the Atlantic is divided into two great hollows by a submarine ridge running out from the Cable Plateau. The eastern and western hollows have different hydrographical conditions. The simplest plan would be to draw the transatlantic line of investigation parallel with the degrees of latitude between America and Europe. The northernmost of the three sections should be studied approximately along the fifty-seventh degree of latitude. This would be comparatively simple. The depths of the Cable Plateau are only from 1,000 to 3,000 meters, and this section would cross all of the so-called "Gulf Stream Branches" in the north Atlantic.

The southern sections should be drawn not transversely, but diagonally. One should extend from the mouth of the Channel north of the Plateau of the Azores to the West Indies and the Caribbean Sea. The second should extend from the Straits of Gibraltar south of the Plateau of the Azores to Trinidad.

The study of those two sections would demand a complete equipment for oceanic deepwater soundings, and a staff experienced in such work on board large ships. The best time would be from December to February, since our knowledge of the condition of the sea is especially incomplete in winter.

The Opportunity

It appears opportune that the first Atlantic survey should be made with ships from the Navy, at a time when such vessels are sent out simultaneously from several European countries along the several routes indicated above. Such an opportunity will present itself at the opening of the Panama Canal in January, 1915. European countries will probably be represented by naval vessels, and scientific investigations could be made *en route*, without great expense or serious loss of time.

The Austrian and Italian vessels, coming through the Straits of Gibraltar, could study the southern section. Since a deep-sea sounding requires only about twelve hours, and a sounding of 1,000 meters only a few hours,

the scientific work would not lengthen the voyage more than a week.

The ships sent by the North Sea countries and by Russia, coming through the English channel, could study a section of the Atlantic north of the Plateau of the Azores. The opening of the Panama Canal, which should stand for universal traffic, would likewise form an epoch in the study of the sea, and introduce a future of international cooperation in the scientific activity of nations.

If this opportunity is neglected, it is not likely soon to come again. Experience has taught the difficulties involved in setting in motion an international undertaking of such dimensions; and the opinion is expressed that the time remaining would just about suffice for the diplomatic, scientific and technical preparations.

In preparing the above synopsis the words of the authors are frequently used.

H. O. Jones

SPECIAL ARTICLES

THE POOR NITRIFYING POWER OF SOILS A POSSIBLE CAUSE OF "DIE-BACK" (EXANTHEMA) IN LEMONS

The disease known as "die-back" in citrus trees has, for many years, worried the citrus growers of Florida and California in this country and has thus far baffled the efforts of the agricultural scientist to discover its cause. The writer has recently made some observations and experiments on several citrus soils bearing trees affected with "die-back," which lead him to believe that a poor nitrifying power on the part of the soil, with the ammonifying power remaining normal, may be the cause of the peculiar manifestations which are characteristic of the disease and which, for the purposes of this preliminary report, need not be described. The theory upon which I am working at the present time, looking toward the solution of this problem, is that in the absence of normal nitrification and in the presence of sufficient ammonification, the tree does not obtain a sufficient quantity of nitrate for its development and is sooner or later forced to assimilate ammonia compounds as produced by ammonifying organisms in the soil; or in the presence of a sufficient amount of bases in the soil even the ammonia may be set free, thus causing the plant to starve for want of nitrogen. While it is true that some plants can use ammonia compounds just as well as nitrates as a source of nitrogen and further, that some of them even prefer the ammonia compounds, as Kelley has shown is the case with rice, it is very possible that we have in the citrus tree, a plant which is deleteriously affected by ammonia compounds when it is forced to absorb them. As above explained, however, when a soil's power to fix and hold ammonia is very feeble, owing to the presence of bases in excess, a poor nitrifying power and a strong ammonifying power may mean nitrogen starvation for plants on that soil. The writer has examined and tested the nitrifying power of four citrus soils in various parts of California, on which trees were suffering from "die-back," and has found in every case a very slight nitrifying power or none at all. The tests were made by adding to soils, kept at optimum moisture conditions at a temperature of 26 to 28 degrees C. for approximately a month, both dried blood and sulfate of ammonia, but only slight or no increases of nitrates over the amount in sterile checks or dry soil were obtained. The dried blood was used also in varying quantities from 1 per cent. up to 5 per cent. of the dry weight of the soil, but the same results were obtained in all cases. In some of these soils, particularly, the ammonification of the blood proceeded so rapidly as to give an intense odor of ammonia when the Petri dish cover was raised from the tumbler in which the soil cultures were kept.

This theory of the writer's which inclines to account for the "die-back" by the fact that too much ammonia is assimilated by the tree under compulsion in the absence of nitrates, or, under certain circumstances, because ammonia is set free and therefore there is scarcely any nitrogen for the tree to assimilate, would also seem to be in part confirmed by the observations made by Florida investigators on the disease in question, in which it was noted that in all cases the application of organic

manures to citrus groves invariably made conditions worse or increased the amount of "die-back." In accordance with the idea above expressed, and in the absence of nitrification, this would be for the reason that either the added organic matter would be responsible for the formation of so much ammonia, which (through its enforced absorption) would poison the plants or because, under some soil conditions, most of the ammonia would be set free and pass off into the atmosphere in a gaseous form, thus inducing nitrogen hunger.

I feel justified in transmitting this brief preliminary note on the subject in question, before the theory has been fully tested out, by the fact that the disease known as "die-back" has been studied in many different ways without giving encouraging results, and, because, further, this new method of attack related to the chemical and bacteriological conditions of the soil, as affecting plant nutrition and as applied to a problem of this kind, deserves to be called to the attention of other investigators working along this or similar lines. I am vigorously proceeding to test out the theory above given by simultaneous greenhouse and field experiments with citrus trees which are now under way, in which, on the basis of what I have said above, I am not only trying to overcome the disease by variously treating soils in the field, so as to provide a plentiful supply of nitrates and reduce ammonification, but I am also making an effort to produce the disease experimentally in the greenhouse with seedling citrus trees on soils deficient in nitrates by the addition to the latter of various ammonia compounds, and to overcome it by means of adding stimulants for the nitrifying bacteria. The writer feels confident that a definite relationship may be shown between the abnormal soil conditions mentioned and the "die-back" of the lemon and perhaps as well of other citrus trees, when the experiments have progressed far enough. The theory above enunciated is not only in accord with the Florida observations, but also with all other observations with which I have become acquainted in respect to the disease known as "die-back." Moreover, it allows for the production of bad soil conditions which will result in a poor nitrifying power through a large variety of causes. Such are, for example, the poor physical conditions of soils, unfavorable drainage conditions, the presence of a vigorous denitrifying flora of one kind or another, and many other chemical, physical and bacteriological conditions, not to mention conditions respecting the origin of the soil which would seriously affect the nitrifying power thereof.

These lines for the most part were written about a year and a half ago when I first formulated the theory, and may need slight revision and some additions in the light of many new facts with which we are now acquainted, but, in the main, the theory seems to be better supported in fact at the present time than it was two years ago. Moreover, it seems very probable now, from a large series of tests which we have been making, that not only "die-back," the true *exanthema*, is to be accounted for by the theory under discussion, but also that the equally disastrous, and much more widely spread disease known as "mottled leaf" of citrus trees is capable of being explained in a similar way, if I may regard a large series of tests on various soils in this state as a reliable criterion. Quite unlike the "die-back," the "mottled leaf" condition in citrus trees is to be found in all citrus districts of California, and is at the present time regarded as one of the most menacing factors in the production of citrus fruit for profit here.

The "die-back" and "mottled leaf" conditions of some districts in this state are becoming so bad as to make it imperative to solve these questions as quickly as possible from the practical standpoint alone. One orchard on which, in particular, the writer is working, has a very large proportion of its trees badly affected by the first-named disease, and most trees in the orchard show some manifestation of the disease. The trees are about four years old and had for a time grown vigorously, and then suddenly began to give symptoms of one of the worst and most widespread cases of "die-back" of which we have knowledge in the state. It is hoped that our experiments may serve eventually to remedy such conditions.

A description of detailed experiments will soon appear.

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THE WATER CONTENT OF THE EMBRYONIC NERVOUS SYSTEM

GROWTH and morphological differentiation go hand in hand in the developing organism, but obviously growth alone can not lead to an increase in the complexity of form without itself being differential. The various tissues and organs of the embryo, however, do grow at different rates, and since, in general, rate and extent of growth are measurable in terms of the rate and extent of water absorption, it follows that differential growth must depend on the ability of the embryonic tissues to absorb and hold, relative to their dry substance, different amounts of water. That this must be true at some period in development follows from the comparative dry substance determinations familiar to every one, but how early in the ontogeny differential absorption occurs has not been known, although its importance as a factor in morphological differentiation has been hinted at often enough.

My investigation of this question was begun on the embryos of *Rana pipiens* in the spring of 1913. The methods employed were tedious but simple. In one series of experiments eggs were allowed to develop normally until a time when the body of the embryo could be cut from the yolk by means of a very thin knife. The division was accomplished easily with a minimal loss of material. Unfortunately the various tissues in the separated portions can not be isolated, but even if this were possible, an unavoidable error due to the presence of considerable quantities of yolk within the cells of the nervous system would remain. However, at the stage of development under consideration, it is safe to assume that the operation results in the separation of two masses, one of which is predominantly yolk, the other, predominantly nervous tissue.

The separated masses were carefully weighed in closed vessels after removal of the superficially adhering water. Following the determination of the fresh weight, the material was reduced to absolute dryness in vacuo over P_2O_5. The results of two series of weighings given in Table I. are:

TABLE I

(*Rana pipiens*)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
24 yolk sacs	.0440	.0204	46.4	53.6
31 yolk sacs	.0585	.0264	45.2	54.8
Average			45.8	54.2
24 nervous systems	.0464	.0098	19.1	80.9
31 nervous systems	.0714	.0149	20.8	79.2
Average			19.9	80.1

Control observations on embryos of *Amblystoma punctatum* were then made, but, owing to technical difficulties, it proved easier to compare the water content of the nervous system with that of the entire embryo rather than with that of the tissues constituting the yolk sac. The results of these preliminary determinations were as follows:

TABLE II

(*Amblystoma* larvæ)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
16 larvæ	.0955	.0399	41.8	58.2
15 larvæ	.0992	.0406	40.9	59.1
Average			41.4	58.6

These figures may serve as a basis for comparison with the water content of the nervous system. As Table III. shows, the values for the latter are identical with those for the frog embryo, and belong to an order of magnitude quite different from the values for the larval body taken as a whole.

Comparing these values with the corresponding ones found for the frog embryos, we may say, within the limits of error, that the larval nervous system of these amphibians is a tissue which contains 80 per cent. of water and 20 per cent. of dry substance.

TABLE III

(*Amblystoma* larvæ)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
52 nervous systems	.1756	.0400	22.8	77.2
15 nervous systems	.0524	.0106	20.2	79.8
69 nervous systems	.2039	.0363	17.8	82.2
Average			20.3	79.7

If we wish to institute a comparison between the water content of the embryonic nervous system and the corresponding adult structure, it is more correct to use the water content of the cord, for this is less differentiated than the brain and consequently more nearly resembles the larval condition. Donaldson[1] has given the water content of 12 cords of *Rana pipiens*. The average is 80.5—identical with my value of 80.1 for the larval system.

Comparisons were also made between the water content of the anterior and posterior ends of the embryonic nervous system. For this purpose I divided 125 isolated larval nervous systems of *Amblystoma* in two, as accurately as possible, in the medullary region. Dry substance determinations of the separated portions were then made with the following results:

TABLE IV

(*Amblystoma*)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
125 larval brains	.1812	.0342	17.2	82.8
125 larval cords	.2102	.0443	21.0	79.0

These results are in the same sense as those reported by Donaldson,[2] as the water content of the brain of an adult *Rana pipiens* is 84.9 per cent., or 4.4 per cent. higher than that of the cord. My results on *Amblystoma* indicate that the larval brain contains more water than the attached cord.

[1] Donaldson, Henry H., "Further Observations on the Nervous System of the American Leopard Frog, *Rana pipiens*, etc.," *Journal of Comparative Neurology and Psychology*, Vol. 20, p. 2.

[2] *Loc. cit.*, p. 2.

We may conclude therefore that the nervous system as a whole has a specific capacity for holding water and that this specificity exists from the beginning. This can be the outcome of nothing other than a physical-chemical specificity, and we must suspect that the nervous system differentiates as a morphological entity, because its chemical differentiation endows it with a specific capacity for holding water. Moreover, two regions as sharply distinct, morphologically and physiologically, as brain and cord have each their own specific capacities, and these although not differing as widely, perhaps, as in the adult, are nevertheless at variance in the embryo in the same sense. The thought lies near at hand, therefore, that the gross structural differences between brain and cord brought about during the course of development are definitely related to the fact that their respective rudiments maintain each its own specific relation between the amount of dry substance and the amount of water.

Otto Glaser

University of Michigan,
April 3, 1914

CONFERENCE ON INDIVIDUAL PSYCHOLOGY

Former pupils of the department of psychology of Columbia University held a reunion and conference at the university, on April 6–8, and on the latter date gave a dinner to Professor James McKeen Cattell in celebration of the twenty-fifth anniversary of his first appointment as professor of psychology. This first appointment was at the University of Pennsylvania, and Professor Witmer, of that institution, one of Professor Cattell's earliest students, participated in the dinner. On this occasion a volume entitled "The Psychological Researches of James McKeen Cattell: A Review by Some of His Pupils," written by Messrs. Thorndike, Wells, Henmon, Dearborn, Hollingworth and Woodworth, was presented to Professor Cattell.

The program of the Conference follows:

Monday, April 6, at 3 P.M.

Chairman, Professor Cattell

"Individual Differences in Sense Discrimination": V. A. C. Henmon (Ph.D., 1905), professor

of educational psychology, University of Wisconsin.

"Individual Differences in Reaction Time:" Sven Froeberg (Ph.D., 1908), professor of philosophy and psychology, Upsala College.

"Individual Differences in the Judgment of Unitary Colors": A. T. Poffenberger, Jr. (Ph.D., 1912), instructor in psychology, Columbia University.

"Possible Effects of Practise on Individual Differences:" Mary T. Whitley (Ph.D., 1911), assistant professor of educational psychology, Teachers College, Columbia University.

"Successive Measurements of Individual Ability": Warner Brown (Ph.D., 1908), associate professor of psychology, University of California.

Monday, April 6, at 8 P.M.

Chairman, Edward L. Thorndike (Ph.D., 1898), professor of educational psychology, Teachers College, Columbia University.

"Individual Differences in School Children": Elmer E. Jones (Ph.D., 1908), professor of the history and philosophy of education, Indiana University.

"The Reliability of Certain Psychological Tests for Determining the Mental Efficiency of Children": Frank G. Bruner (Ph.D., 1908), assistant director, department of child study, Chicago Public Schools.

"Feeble-minded Children as a Species": Naomi Norsworthy (Ph.D., 1904), associate professor of educational psychology, Teachers College, Columbia University.

"Correlations between Entrance Examination Grades and College Records": Adam Leroy Jones (Ph.D., 1898), chairman of the committee on undergraduate admissions and associate professor of philosophy, Columbia University.

Tuesday, April 7, at 3 P.M.

Chairman, R. S. Woodworth (Ph.D., 1899), professor of psychology, Columbia University.

"Cranial Measurements in Relation to Intelligence": W. C. Ruediger (Ph.D., 1907), professor of educational psychology, George Washington University.

"The Intelligence of Negroes": Marion J. Mayo (Ph.D., 1913), head of department of mathematics, Eastern District High School, Brooklyn.

"The Psychological Point of View in Ethnology": A. A. Goldenweiser (Ph.D., 1910), instructor in anthropology, Columbia University.

"A Note on Primitive Association of Ideas": Robert H. Lowie (Ph.D., 1908), associate curator of anthropology, American Museum of Natural History.

"The Measurement of Attention": Herbert Woodrow (Ph.D., 1909), associate professor of psychology, University of Minnesota.

"The Relation of Recall to Recognition Memory": Garry C. Myers (Ph.D., 1913), instructor in psychology, Brooklyn Training School for Teachers.

"Visual Rhythms:" Kate Gordon (Ph.D., Chicago, 1903), professor of educational psychology, Bryn Mawr College.

Tuesday, April 7, at 8 P.M.

"Some Applications of Psychological Tests to the Determination of Industrial and Professional Fitness": B. B. Breese (Ph.D., 1899), professor of psychology, University of Cincinnati.

"Individual Psychology and the Problem of Vocational Guidance": F. G. Bonser (Ph.D., 1910), associate professor and director of industrial arts, Teachers College, Columbia University.

"The Reliability of Judgments of Mental Ability, with Applications to the Selection of Persons for Positions": B. R. Simpson (Ph.D., 1912), instructor in psychology, Brooklyn Training School for Teachers.

"Relation of Earning Power to School Performance": D. Edgar Rice (Ph.D., 1912), secretary, Pratt Institute.

"An Empirical Study in Valuation": E. K. Strong, Jr. (Ph.D., 1911), fellow in advertising, Columbia University, appointed professor of psychology, George Peabody College for Teachers.

"An Empirical Study in Valuation:" E. N. Henderson (Ph.D., 1903), professor of education, Adelphi College.

Wednesday, April 8, at 3 P.M.

"Traits of the Psychoses from the Standpoint of Individual Differences": F. Lyman Wells (Ph.D., 1906), psychologist at McLean Hospital; lecturer on pathological Psychology, Harvard University.

"Indications of a Connection between Accidents, Divorce, Alcoholism, Illegitimate Birth and Mental Defect": Siegfried Block, M.D. (M.A., 1910), Medical Examiner, Children's Court, Brooklyn.

"Further Studies of the Only or Favorite Child in Adult Life": A. A. Brill (M.D., 1903), chief of clinic, department of psychiatry, Columbia University.

"Individual Differences in Dreams": Lydiard H. Horton (M.A., 1911), interne in psychopathology, Boston State Hospital.

"Practical Aspects of Individual Differences in Practicability": H. L. Hollingworth (Ph.D., 1909), assistant professor of psychology, Barnard College, Columbia University.

"The Activity Attitude and Meumann's Individual Types of Will": Margaret Floy Washburn, Ph.D., professor of psychology, Vassar College.

Others whose names were on the printed program, but who were unfortunately unable to appear, were Professor Walter F. Dearborn, of Harvard University; Professor S. I. Franz, of George Washington University, and scientific director at the Government Hospital for the Insane, and Dr. Edwin Grant Dexter, director of the Canal Zone Museum at Panama.

R. S. Woodworth

SCIENCE

FRIDAY, MAY 22, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE SOCIAL OBLIGATIONS OF THE BOTANIST[1]

THE subject of the address which I am to have the honor of presenting before you this evening was suggested to me on hearing recently a statement to the effect that it is the duty of society to pay for the services of the botanist. It seems to me that there is something to be said on the other side of this question, and, although my predecessors on similar occasions have almost invariably favored you with learned scientific discussions, I shall depart from that ancient and time-honored custom and invite your attention to a consideration of some of the social obligations of the botanist.

A distinguished and honored member of this society has defined botany as that science "that occupies itself with the contemplation of plant as related to plant, and with the whole vegetable kingdom as viewed philosophically—not economically or commercially in its relation to the mineral, on the one hand, and to the animal on the other." From this definition it naturally follows that a true botanist is one who is engaged in research upon plants as such without regard to the relationship they may bear to the welfare and activities of mankind. The history of botany clearly shows that botanists have ever been largely devoted to their science for its own sake, for the pleasure which they might derive from a knowledge of plants. The speculations in which they were absorbed concerned questions of truth and not those of economic values. But throughout the history of the race, the economic aspect of

[1] Address of the retiring president before the Botanical Society of Washington, March 3, 1914.

plants has been of fundamental importance to man, since upon them he has ever looked not only as the chief source of the three great necessities, food, clothing and shelter, but also as the means whereby he might cure his bodily ills or otherwise contribute to his comfort and satisfaction. As society became more and more highly organized, there emerged groups of men whose interest centered upon some particular phase of plant utilization which through long-continued study and observation became sufficiently developed to be recognized as an art. The lineal descendants of these groups we recognize to-day in our practical gardeners, horticulturists, foresters, agriculturists and pharmacists. The radical difference in the point of view, between those devoted to botany as a science and those engaged in the practise of its art, ultimately led to the development of a species of class consciousness more than traces of which unfortunately are still in existence. The botanist dazzled by continued contemplation of the aphorism "science for science's sake" became unable to see any science in the practise of the art of botany, and relegated its followers to the limbo of tradesmen along with the smiths, the carpenters and the shoemakers. On the other hand, the groups interested in the practical or industrial aspects of plants came to look upon the professional botanist as a harmless individual who succeeded very well in entertaining himself, but whose activities were of little if any significance to those whose primary interest in plants was utilitarian.

This class conscious attitude on the part of those who approached the study of plant problems from such widely different points of view led to results of the most profound significance. Botanists in their zeal to preserve their ideal unsullied, and in their fear lest utility should obscure its luster devoted themselves almost exclusively to a dendritic development of their science, the industrial branches of which remained rudimentary if they were not wanting entirely. Until within recent years, the concept of the function and content of the instruction in botany given in our colleges and universities was derived purely from a consideration of the philosophical aspect of botany. In some institutions at least the sentiment prevailed that the courses in botany planned primarily to develop the scientific attitude of mind and habits of thought, had as their chief and legitimate goal the training of students to become teachers of botany. But notwithstanding the increase in the number of institutions of learning, and the consequent multiplication of opportunities for the teacher of this subject to secure a position in which he could maintain himself in a modest way, the possibility of earning a livelihood as a teacher became more and more remote, as an increasingly large number of students graduated and became available as teachers of botany. The inevitable consequence was that many men were turned aside from the pursuit of botany as a profession and entered upon other vocations, which promised to be more remunerative.

But at length there dawned a new conception of botany, one destined not only to modify profoundly the opinion of the public at large with respect to this science, and to revolutionize in many respects the attitude of its exponents in the lecture room and laboratory, but also to pave the way for bringing into sympathetic understanding the workers in widely separated fields of botanical activity. The causes underlying the development of this new conception, which in brief is the recognition of the fact that botany may be utilitarian and still be botany—may be reduced to two, one of which is economic, and the other social.

The economic cause is to be found in the tremendous expansion of technological enterprises which is characteristic of this industrial age. Developments in the field of agriculture have created a demand for men who have been trained to deal with plants in their practical aspects. Trade and industry have recognized the value of the aid which is to be had from science, and have fostered schools for education along technical lines. In response to the demands of technology, many scientific workers have directed their attentions to practical problems, and one result of their combined labors is seen in the change of point of view with respect to botany, and the wider recognition of its utilitarian phases.

The existence of what I have called the social cause, as well as the part which it has played in reshaping the conception of the proper sphere of botany, may not be readily granted, but its absolute denial would certainly impugn the motives of many of the most devoted and conscientious workers in this field of science. This cause had its origin in the fuller realization and clearer perception of the social obligations of botanists. By social obligation is not meant the friendly association with fellow-workers, or the attendance on dinners, and dances, or afternoon receptions, but the obligation of the botanist, as a botanist, to society as a whole.

So long as botanists were economically independent, or so long as they found it necessary to rely upon some regular profession for a livelihood and devoted only their leisure hours to the acquiring of knowledge regarding plants, they could justly be held accountable only to themselves for the nature and direction of their studies. But as economic development advanced, and division of labor became more pronounced, many people of leisure and culture found it necessary to devote their attention almost exclusively to their business affairs, and the number of professional botanists of independent means became absurdly small in comparison with the number of those who received compensation for their services. For society, recognizing that education along broad and liberal lines was of paramount importance in the upbuilding and perpetuation of our social institutions, has endowed professorial chairs, built commodious structures and supplied the means for securing the extensive equipment necessary for the prosecution of research and the giving of instruction as well as for the support of the teachers and investigators. Thus the economic status of the botanist changed and brought about a corresponding modification in his social obligations, which in turn led to a broader appreciation of the significance of service. Whoever accepts support from another, be that other an individual or society as a whole, does so either upon the basis of charity or upon the condition of giving an equitable return in service rendered. There is no one worthy of the name of botanist who does not scorn the former, and perhaps none who is not satisfied that he is meeting the latter condition. But who is to be the arbiter as to the equitableness or character of the service rendered? The botanist? Yes, if he is deeply imbued with a right sense of his obligation to society, but if not, if he is one of those who mistake knowledge for an end itself instead of a means to the broadening and energizing of human existence, society will sooner or later relegate him to the place now occupied by the astrologer and the alchemist. Society then has the right to demand, and it is the obligation of the botanist to render service that has a distinct and plainly discernible economic or social value. This does not mean that botanists should con-

sider plants only from the industrial point of view, but it does require the abandonment of the dogmatic attitude which has so long been hostile to any union of philosophical interest and industrial needs. It means the obliteration of the class line between the nobility of wild growing plants and the bourgeoisie of cultivated species; it means the recognition and acknowledgment by teachers and investigators that very practical and commonplace subjects, such, for example, as the germination of ordinary garden seeds, often present as profound theoretical problems as those which are far removed from the field of possible utility; it means the recognition of the principle aptly stated by a recent writer in another connection that "It is the interaction of various types of human thought and investigation, and not mutual isolation or contempt, which helps us all, while he does best who works with the profoundest theoretical problems and the most intensely practical interests at once pressing upon him, with the widest and most philosophical breadth of view, and the most faithful special labor, at once demanding attention."[2]

The socialization of industry and the specialization of almost every line of human endeavor has necessitated fundamental changes in the spirit and methods of education. No longer is the hope held out that more than a fraction of the students that fill our schools and colleges can win a competence in the learned professions, and large numbers must be encouraged to look for their life work in some line of activity closely associated with industry. To such of these as may choose an occupation in which practical knowledge concerning plants will be of benefit, the social obligation of the botanist is clear. He should encourage rather than discountenance investigations of a very practical nature, relying upon his own endowment with the true scientific spirit to so shape and direct the work of his students that it may lead to the development of the desired scientific attitude of mind toward the fundamental principles of plant life. To be sure it will be objected that in such a course lies the danger that education will become a merchandise and science be degraded into a mere trade. It is feared that the time spent in learning anything which can not be turned into money will come to be considered as lost and that no longer will there be any interest in the search for truth that does not bear the earmark of utility. It seems to me, if there is any danger to the future of botanical science, that it lies in an entirely different direction, that is, in the failure to recognize the great possibilities for the development and stimulation of widespread interest in the more theoretical aspects of this subject, growing out of its relation to the material affairs of men in general, for just as our social workers have learned that religion offers poor comfort to the man whose stomach is empty, and whose body is imperfectly clothed, so botanists must come to see that their philosophy will mean little or nothing to the great mass of society unless it finds some expression along lines of human interest and necessity.

It is a social obligation of the botanist to insist that the standards by which he is to be judged shall be those of personal value rather than the standards of wealth. Measured by the latter, his position in the economic scale may be regarded as comparable with that of the wage-earner or his fellow worker in the trades, whose usefulness to society is largely measured by his ability to adapt himself to the material and often mechanical requirements under which he must perform his task. The usefulness

[2] Royce, J., SCIENCE, N. S., Vol. 38, 1913, p. 584.

of the botanist, however, can not be so measured, for the service which he renders to society is of an order entirely different from that of the craftsman. His work is to explore the boundaries of knowledge in his search for additional truth, to break the bonds of tradition and opinion when they fetter progress in the solution of scientific problems, and through creative thought to advance the science of botany and its useful applications. The value of his service is not necessarily conditioned by his salary, his degrees, his hours of work or the number of his printed pages, but it does depend, in part at least, upon his open-mindedness to truth, upon his ability to direct his efforts along productive lines, upon the validity of the conclusions based upon his researches, upon the contribution which his discoveries make to social welfare, and upon his power to inspire and right to retain public confidence in the value of botanical investigations. Through his deep sense of community of interest and the recognition that his studies may be of service to all mankind, he thus places himself beyond the pale of economic class distinctions, and is entitled to be judged solely by his personal value.

Nevertheless, botanists themselves have a tendency to judge each other by standards which fall far short of those of personal value. Too often is the sign accepted at par value when the thing signified is only debased currency. An array of scholastic degrees and a long list of titles of published articles may gain for the fortunate possessor a recognition wholly disproportionate to the service he is rendering either to science or to society. The much-deplored tendency to "rush into print" on slight provocation or on no provocation at all, and the frequent occurrence of the legend "Read by title" in the proceedings of our societies and associations, is at least presumptive evidence that judicious advertising is not without its reward to the individual irrespective of any other results that may follow. The objection which may here be made, that men who are widely separated can come to know each other's work only through their respective publications, answers itself, for the argument is entirely against setting up as standards of measurement, degrees, instead of the personal value to society of the man bearing the degree, and against regarding titles of publications rather than the merits of the publications themselves.

When scientific men overestimate the importance of its symbols to the neglect of achievement itself they give hostages into the hands of those who seem to think that scientific activity can be measured according to some fixed standard, and its value expressed in numerical terms. They also limit and restrict their usefulness to society when too much account is taken of those personal distinctions which are often made between workers in different lines of scientific activity and sometimes between those in lines which are closely related. It is necessary to emphasize the standard of personal value and to insist that a clear distinction be made between the nature of the task of the scientist and that of the industrial worker if the former is to remain free from checks and hindrances which are incompatible with true scientific progress, and if he is to be awarded recognition on the basis of his real contribution to the progress of civilization.

It is a social obligation of the botanist to be a man of affairs. The outlook for the future is that the bond between scientific investigation in botany and economic work will become closer and stronger, and that botany, already occupying an important place in the applied sciences and in human affairs, will gain even wider recog-

nition as one of the permanent forces underlying social progress and activity. Time will bring greater and more insistent demands for the extension of inquiry into every field where the application of the fundamental laws and principles developed through the scientific study of botany promises to minister to the needs of humanity. The organization and direction of the botanical work of the immediate future, in a manner that will preserve the proper balance and correlation between scientific research of the broadest and most fundamental character, and investigations undertaken largely or entirely for economic ends can be successfully accomplished by men who are not only broadly trained botanists, but who are men of affairs, as well.

Scientific progress is not accomplished by the mere accumulation of knowledge, but follows only when knowledge is communicated and brought within the grasp of all who are able to utilize it in any phase of human endeavor. The rapidity with which new knowledge makes its way and the extent to which it finds ready acceptance and assimilation depends upon the terms in which it is formulated, upon the clearness and thoroughness with which its relationship to other forms of knowledge is presented, and upon the number and variety of its possible applications which may be pointed out. Manifestly, he who will succeed best not only in securing the fullest appreciation and utilization of the results of his work, but also in obtaining merited personal recognition for his services, is he who retains a broad and liberal point of view with respect to the related branches of his science, and who is able to put himself into sympathetic relations with men who differ widely in interest and activity.

The scientific worker who would remain in the most active lines of modern progress, and who appreciates the disappointments and discouragements that often fall to the lot of one who has failed to keep in sympathetic relations with the spirit and purpose of the age in which he lives, will find it desirable not only to acquaint himself with developments in lines of scientific investigation widely separated from his own, but also to extend the scope of his mental horizon until he can obtain a clear view of the readjustments and changes which are constantly taking place in the domains of industry and education and in the fields of political and social affairs. The idea here expressed may be regarded as wholly fatuous and incapable of realization, but the fact remains that specialization alone will lead to a dendritic or tree-like development of science, which instead of conducing to general progress, will ultimately operate as a hindrance to it. Indeed, the development of a science is in many respects analogous to the evolution of a species of organisms, for just as the latter make evolutionary progress (I here quote a well-known writer on organic evolution) only through being "connected with each other by an intricate network of descent in the weaving of which the diversities of the members of a species have a definite physiological value," so will a science approximate the maximum limit to its capacity for progress only through the continuous interaction of the ideas and the integration of the principles developed in its various phases and aspects.

It is a social obligation of the botanist to study processes, to penetrate more deeply into the mighty forces of organic nature to the end that they may be brought more completely under the control and direction of man. The satisfaction of human wants is in a large degree dependent upon processes which have been slowly built up by plants through countless ages of

gradual development, and since the laws governing them are not sufficiently well understood, these processes have played a small part in the advancement of industry. We have no choice, for the most part, but to accept such products as the plant may yield, instead of being able either to fully control its activities, or having discovered the secret of its processes, to utilize them in the direct production of desired materials. The problems here involved are fundamental in character and can be solved only by scientific research of the highest order. It is not a question of applied science, but a search for the underlying principles which may lead to a full understanding of the functioning of plants, and the scientific worker who achieves success in this field will not only make a noteworthy contribution to science itself, but will also make possible profound and advantageous changes in the world of industrial affairs.

No less important than the investigation of the processes of plants themselves is the study of the processes by which they have come to be what they are. In this lies one of the most fundamental problems of modern botany, a problem which involves no less than the ultimate elucidation of the laws which have determined the evolution of the vegetable kingdom. The successful solution of this problem promises results of profound significance, and advanced workers in this line of botanical activity have predicted that the time is almost at hand when our present system of classifying plants will be supplanted through "the discovery of a system which shall depict plants in their evolutionary sequence."

The botany of the future will be more and more concerned with a study of the very recent stages in the descent of the living flora, and there can be no doubt that this line of research will be greatly stimulated by economic considerations. The efforts to bring under control those processes by means of which improved species or varieties may be originated, will lead to a much wider study of plants, and to a critical study of their relatives from widely separated situations. In arboretums and botanic gardens as well as in the great herbariums there will be brought together collections of materials for use in the investigation of genetic relationships. For the future, it is not too much to hope or expect that in proportion as our knowledge of these relationships increases corresponding advances will be made toward a solution of some of the complex problems of evolution and heredity.

It is a social obligation of the botanist to be efficient. Stein[8] in his brilliant work on the philosophy of society observes that "The sense of obligation can never be derived from biology." It would seem to be self-evident that the complex facts of human life and experience can not be rightly interpreted by the same natural laws which govern the growth and development of a biological organism, although the latter view has not been without its exponents and followers. But public opinion, though long suffering, can not be depended upon to forever countenance those scientific workers whose attitude toward society is expressed by the old doctrine, "mind your own business," and whose rule of conduct recognizes no influence or appeal that lies beyond the limits of their science. The service of highest efficiency, however, will be rendered by those who through experiment, observation and generalization, succeed in dispelling the mists of shadowy suggestion which have prevented a clear view of many facts of nature, and who at

[8] Stein, "Die soziale Frage im Lichte der Philosophie," 1897, s. 222.

the same time prepare the way for their widest application and utilization.

The efficiency of the scientific worker bears a very direct relation to the motives which guide him in his work. The temptation to follow the line of thought or study that for the time appears most attractive is very great and for some irresistible, and advance in one direction proceeds only until a new and more inviting path is crossed, but the scientist who pursues such a wavering course is apt to be like the aeronaut, very much in the air. The most effective workers are those who have the greatest power of sticking to a subject until every means of forcing the truth to reveal itself has been exhausted. As the necessity increases for a general attack upon the more difficult and fundamental problems, the greater is the demand for patience and perserverance in the prosecution of investigation. The homely, but expressive saying, "It's dogged as does it," which was often quoted by Darwin, illustrates a mental characteristic which has led many a man to overcome apparently insurmountable difficulties.

It is also easy to fall into the error of assuming that the collection of data is science and that whoever actively and industriously accumulates a large collection of observations on various natural phenomena thereby contributes largely to scientific progress. But the application of thought in lines that lead to definite and tangible results, and the collection of data to some useful purpose, "will always have as their guiding motive the testing of some tentative hypothesis needed for the explanation of our experience." The shelves of our libraries bear many a musty tome in which are recorded countless observations on the phenomena presented by plants, but many of these observations have little meaning for science to-day either because they were not made with sufficient discriminating care and precision to give them scientific accuracy, or because they lacked the correlation with well established facts necessary to their interpretation in harmony with later discoveries. Other observations have remained in oblivion or conscious neglect, either because of the accident of their place of publication or because they did not appear in one of the "recognized" mediums of scientific utterance. It seems reasonable to assume that the scientific accuracy or validity of published observations or conclusions depends upon the efficiency of their author rather than upon the place of publication. Those who regard a restricted group of books and journals as a canon to which alone they look for authentic scientific utterance, and regard all others as apochryphal do but perpetuate the ancient schism between the botanists, on the one hand, and the gardeners and horticulturists on the other.

Efficiency implies not only a wide knowledge of facts, but also a breadth of view which will enable the relations between various categories of facts to be seen clearly. How the lack of understanding of the known phenomena and facts may operate to retard the diffusion of knowledge is well illustrated by the failure of contemporary scientists to understand and accept the discoveries of the early plant breeders. While the gardeners were making discoveries the importance of which was not recognized until nearly a century later, the real scientists were occupied with the recognition and classification of species. The failure of botanists to give credence to the early investigations in plant breeding has been variously explained, but we may well accept the view of Focke[4] that "these discoveries did not fit into the idea of nature then

[4] Focke, W. O., "Die Pflanzen-Mischlinge," 1881, s. 433.

current, for they could not be reconciled with the known facts and therefore were disregarded."

The obligation to be efficient in the avoidance of error is by no means to be taken lightly. The young writer who excused his carelessness of statement and inaccuracy of citation by saying "everybody makes mistakes" no doubt uttered a truism, but he also displayed his profound ignorance of the difficulty with which a misstatement is rectified when once it has gained a footing in literature. There is perhaps no more striking example of the strange fabric that may be woven with the warp of truth and the weft of oversight or error, than the biological principle known as Von Baer's law.

Von Baer is renowned as the originator of the theory that the embryo of every higher animal during its development passes through successive stages in which it simulates the adult forms of the lower animals in the same phylogenetic series. But Von Baer did not originate this theory, indeed he was its most vigorous opponent. What he really taught was that the embryos of different animals are similar to each other in that they adhere to the same plan of development, but through the failure of some of his contemporaries to be precise and discriminating, the ideas of another man were mistaken for those of Von Baer, and the latter was thereby placed in a false light in respect to the contribution which he made to science.

Manifestly a high degree of efficiency is just as desirable in interpreting and citing the writings of other workers, as it is necessary in planning and successfully conducting the work of experimentation, and the scientific worker who renders the best service both to himself and to his science will be as zealous in avoiding the perpetuation of error as he is ardent in his search for truth.

It is a social obligation of the botanist to strive for a better organization of his science. It is not my intention to raise that much-discussed question "What is botany?" the answers to which are approximately as numerous as those who are or who think themselves botanists, although I deprecate the contrariety of opinion which exists with respect to what may properly be included in the domain of this science. Some maintain the old distinction between pure and applied science, and would exclude from the science of botany such subjects as plant breeding, economic botany and plant pathology; others think botany is largely an applied science, consisting in part of mere applications of other sciences; some conceive the science as largely restricted to one of its phases, as, taxonomy, morphology or physiology; and still others maintain that botany is not a single science but a group of distinct sciences with nothing in common except the fact that they are concerned with the phenomena presented by plants.

Segregation and specialization in various lines of botanical activity seem to be a natural process necessarily attendant upon scientific progress. Competition between these lines, each of which seeks to gain the ascendency, and to become recognized as the true representative of the science, also seems not only natural, but necessary to normal and progressive development. There exists, however, a sufficiently close analogy between the evolution of a science and certain phases of organic development to justify the consideration of a well-established biological principle in discussions of the relative importance of different branches of the science, or the promise which they hold out of contributing most to its advancement. This prin-

ciple states that "the point of departure of the progressive lines of one period of time has not been from the terminal types of the lines of preceding ages, but from points farther back in the series." The evidence is not wanting that the new and progressive lines of botanical activity do not originate directly from the most highly specialized branches of the science, but from the more unspecialized portion. Thus arose ecology, pathology and genetics, and so doubtless will the future see the origin and development of other important and vigorous branches of this science.

It seems inevitable that from time to time each branch of the science will pass through eras of reconstruction unless, indeed, "it is assumed that the existing order is a closed system within which men can and should rationalize their conclusions, but only within that system and ever under its authority." But such a philosophy is incompatible with the modern spirit of progress, which is constantly utilizing accumulated experience in the development of new points of view and demanding a frequent readjustment of the relations existing between allied lines of investigation. The organization of the science, however, implies much more than the harmonious adjustment of relations between its various branches, or agreement as to their proper sphere of activity. It requires that botanists realize that their duties are not fulfilled by investigation alone, but that there is also incumbent upon them the obligation to give serious consideration to what for want of a better term may be called the business affairs of the science. If the great body of investigational work now in progress is to have continued growth and opportunity for unrestricted expansion, the means must be forthcoming to provide for its support, and to assure the protection of its interests. Society must be looked to as the source of these means, and how freely they are given and what restrictions or limitations are imposed with respect to the manner in which they are to be applied will depend largely upon the degree to which there is developed in the public at large a sympathetic appreciation of the aim and purpose of the science of botany.

It is relatively easy to obtain financial support for a scientific enterprise which promises speedy returns in kind, but when the energy expended in such an enterprise is devoted solely to securing showy and immediately practical results, then does scientific education become a mere matter of merchandise and science itself is degraded to the level of a trade. Public support to scientific enterprise must be secured on some other basis than that of annual dividends. Results of great and permanent benefit to society may rightfully be expected, but they must be looked for in the better understanding of the forces of nature and their application to the promotion of human welfare, in the development of constructive habits of thought, which tends to forecast the future by an analysis of the facts of the present, and in the social progress which will be favored by a clearer perception of the relations existing between plants and man.

It is fruitless merely to affirm that more attention should be given to the claims of science, or to condemn the non-scientific classes for estimating the importance of scientific work according to its money value. I am persuaded that the much-deplored tendency to look for immediate and practical returns from scientific work is due less to crass and sordid motives than to a lack of right understanding of the manifold ways in which science exerts a beneficent influence upon the affairs of men. This disability, however, is not beyond remedy, and will be much less in evidence

when greater attention is given to the education of the individual along lines which will lead to a better perception of the real meaning of science. Organization and unity of spirit and purpose directed to the scientific education of the public are essential if practical men are to be brought to see that their interests will be furthered by encouraging scientific work and if society is to be depended upon for its liberal support.

Finally, it is an obligation of the botanist to recognize the beneficent influence of personal association. The inspiration gained by participation in the annual meetings of our scientific societies and associations is too well appreciated to need elaboration or comment. Similarly, the importance of the close personal relation between the student beginning research and his instructor is clearly understood. But it is of the possibilities which lie in the closer personal association between the junior and the senior members of this society that I would speak. It is sometimes said that the younger generation is inclined to be dogmatic, self-sufficient and somewhat disregardful of the wisdom and knowledge acquired by their elders. If this be true, it is largely because the printed page has been substituted for the more natural means of communication between individuals. But the printed page transmits very imperfectly the intangible something we call personality, that power to kindle in others the fire of enthusiasm, to develop that point of view which leads to creative thinking, and to point the path to that insight and vision which has been attained by those of riper wisdom. The younger generation needs the personal inspiration and guidance which it is within the power of their elders to give, nay, more, they stand alert and expectant awaiting the time when their natural leaders may signify their willingness to give them counsel and instruction. When the senior members of this society raise the banner of wisdom and experience, and sound the assembly call, they will find their juniors quick to desert the paths which, like those in a woods, end nowhere, or which lead over the heights of purely intellectual gratification, or through the picturesque valleys of individualism, and, rallying to their standard, be content to march together along the broad road of cooperation, and united effort, which ultimately leads to the heights of progress. And then when our leaders shall approach the end of life's journey, they will have the satisfaction of knowing that although their printed works may soon be superseded or sink into oblivion, the influence of their inspiration and personality, perpetuated through their friends and fellow-workers, will endure for all time.

W. W. Stockberger
U. S. Department of Agriculture

PREMEDICAL EDUCATION

In Cincinnati on January 17, 1914, a conference was held under the auspices of the faculty of medicine of the University of Cincinnati. Representatives of many medical colleges and of academic institutions had been invited to be present at the meeting and to participate in the discussion upon what has been called, very widely, "premedical education." The object of this conference was to draw together the academic and medical institutions for the sake of more satisfactory preparation of students for medicine.

In opening the conference the chairman spoke as follows:

In a lecture to his students in 1821, Dr. Graves said that the practise of medicine can not be taught or learned by hearsay. Later in his introductory lecture at the opening of the session of 1837–38 he enlarged upon his former remarks, and said: "No profession requires a sounder preliminary education than ours, and in none ought education to be more studiously directed to promote

the activity and development of the mental powers, especially those connected with the habit of observation as well as with the judgment and memory." Dr. Graves realized the importance of individual judgment which must be based upon trained observation, and the dangers of the memory method which is always founded on authority. He was interested in premedical education.

This conference has been arranged for the purpose of centering your attention upon the problems of medical education, and especially of premedical education. It is evident to those of us who are medical teachers that if we are to keep medicine what it is said to be and what often it is not—one of the learned professions—we must have the assistance and the active cooperation of the colleges of liberal arts and sciences. It is to the colleges of arts and sciences that we must look for sound preliminary education for medicine.

For exercise and development of the powers of observation the sciences, physics, chemistry and biology, are most important. The laws of these are constantly applied during the whole life of the physician. Without them the study and practise of physic becomes an affair of memory instead of being one of reason. More and more the problems of medicine are coming to be chemical problems—biochemical, if you please. Biochemistry is the chemistry of the tissues and fluids of the body. These materials belong to that comparatively new class which we call colloids which are investigated most satisfactorily by physico-chemical methods. Physics and chemistry are therefore the basis of the study of the phenomena of life. There is not room in the medical curriculum for these subjects. They must belong in the premedical years—to the courses in colleges of arts and sciences, and in such colleges they must be thoroughly studied in laboratory courses. They can not be studied in lecture courses. We therefore wish to discuss the matter of satisfactory courses in physics, chemistry and biology.

It is almost unnecessary to say that with this science training, language work should not be neglected. This is especially true of English. Many of our otherwise well-trained students are deplorably ignorant of their own language. They need German and French, to be sure, but they need to be able to use their mother tongue. We wish to discuss the matter of English, German and French.

So much for the subject matter of premedical courses.

The quality of the students is just as important. The medical schools of the first grade are interested in teaching a few good students, not in teaching large classes. The United States is already overstocked with doctors. It needs no more physicians, but it needs better ones. The influence of these facts is shown already in the attempts of certain schools to limit the number of students in their classes. With good students in small classes we expect to obtain better results than we could possibly expect even with good students in large classes. Mass teaching is never successful.

Small classes of good students in medical schools will be useful in another direction. The teaching will improve. The colleges of arts and sciences can affect the character of medical teaching by sending only well-prepared students to medical schools. Good students are critical and teachers are very susceptible to criticism.

So, for the good of both colleges of arts and sciences and of medical colleges, a cooperative arrangement should have the greatest value, and such an arrangement should ultimately affect to a considerable extent the whole medical profession and, through it, the general public.

There is another important aspect in this proposed closer association of medical schools and colleges of arts. You know that, as a rule, the state standards for practise tend to lag behind—to be influenced by medical schools of the lower grades. If the colleges of arts will let it be known to their students that without two specified premedical years in college science they can not practise in the Dakotas, in Iowa, in Minnesota, Colorado, Indiana or Kentucky—that is to say that certain states will not consider them sufficiently well-educated to practise—the colleges themselves will be benefited; the medical schools will be helped; the schools of a low grade will be embarrassed, and the state boards will be stimulated to be more active in enforcing standards which will make it more possible to protect the public from the half-educated doctor.

I hope that at this conference we may be able to come to some understanding which will make it possible for us all, and for others who are not here to-day, to work toward the ends which I have suggested. It is for the benefit of all the people that we are working. The people are subject to ill-prepared doctors; they are preyed upon by quacks and charlatans. "The higher the standards of education in a profession, the less marked will be the charlatanism."

Following these remarks a series of short prepared papers were devoted to the methods

used and the scope of "premedical" courses in biology (Professor Guyer, of Wisconsin), in chemistry (Professor Jones, of Cincinnati), in physics (President Ayres, of Tennessee) and in modern languages (Professor Brandon, of Miami). Following these papers the meeting was opened for general discussion in which many members of the conference took part.

The gist of the discussion appeared to be that certain preliminary work was necessary for medicine, and that certain other preliminary work was advisable. Furthermore, it seemed that the necessary work should lie in biology, physics, chemistry and a modern language, preferably German; that a substantial enough knowledge of these sciences could not be acquired in a single premedical year; and that while it might be acquired in two years of college work, no time was allowed in a two-year course for various studies, such as psychology, logic, economics and other advisable subjects. Also, it was said that even at the present time the average age of graduation in medicine was about 27.5 years, and that there was evidence of wasted time somewhere. Again it was urged by some members of the conference that a sharp uniformity of preparation was not a wise thing to accomplish, but that some latitude should be allowed in preparation, provided only that students who intend entering upon the study of medicine should be well equipped with a working knowledge of the fundamental sciences, and enough of the humanities to insure breadth.

Before adjournment a resolution was adopted and sent to every college represented at the conference. Later other colleges and even a few individuals were included in the list. The resolution follows:

In view of the ideas expressed in this conference,

Be it Resolved, That the representatives of the various colleges confer with their respective faculties to ascertain:

1. What courses of a premedical nature are offered by them in chemistry, physics, biology and languages.

2. What changes, if necessary, can be made to establish uniformity of essentials in premedical training.

3. Whether it is possible to reduce the total time now required to obtain the M.D. degree, by eliminating duplication of work existing in graded schools, high schools, colleges and medical schools. Your committee is of the opinion that this is feasible.

4. What arrangements are made for granting the bachelor's degree after satisfactory completion of two or three years' college work and one or two years in a Class A plus medical school, and,

Be It Further Resolved, That the action taken by the various faculties be reported to Paul G. Woolley, University of Cincinnati, chairman of the general conference committee, for tabulation, and that this committee may, at its discretion, call another general conference of the colleges interested in this movement.

(Signed) M. F. Guyer, *Chairman*,
Harry H. Holmes,
Lauder W. Jones,
Henry McE. Knower,
E. L. Rice

By the time that the resolution was ready to be mailed a communication had been received from Professor Holmes, of Earlham College, which it seemed might furnish an excellent basis for faculty and departmental discussion. Accordingly, Professor Holmes's letter was embodied in a communication sent to each college. This letter was as follows:

My Dear Sir: The following remarks have come from Professor Holmes, of Earlham College, who was a member of the Cincinnati Conference on Premedical Education. It seems to me that these suggestions furnish a very thorough basis for the discussion of Premedical Courses in Colleges of Arts and Sciences.

"I want to suggest that our committee (or yours) map out a fairly definite three years' course of college work and persuade a large number of colleges to grant the degree of B.S. or A.B. on the satisfactory completion of this and one year's work in a 'Class A Plus' medical school. It does not meet the situation to arrange this unless nearly all the work is rather strictly outlined. Three years of general elective work could be a very poor preparation for medicine and the whole effect could be a hodge-podge not deserving the A.B. or B.S. degree. We must have a consistent major *medical and premedical*, for this period.

"The present 'Class A Plus' requirements of only two years college work, even though certain needed subjects are specified, cuts short the foun-

dation of chemistry so desperately needed in medicine, permits of but one modern language (because of limited time), and yet both German and French are required at Johns Hopkins and needed everywhere, and if the student attempts to take both chemistry and biology during these two years he can carry physics only at the expense of loading with three sciences at the same time—questionable in college. This plan doesn't allow for general culture.

"How much better to have the student of medicine splendidly prepared in all the fundamental essentials of his profession by three years in a college atmosphere with a little time for broader culture. Many who are not willing to spend four years for a college degree or three years as indicated would do so if they were to be rewarded with such a degree after the first year in the medical school. The standard of medicine would be raised and colleges themselves hold their students longer than at present. A few who now take four years might stop with only three, but this would be more than made up by the two-year students who remain for three years.

"Of course the state universities and some others have an arrangement for granting the B.S. to *their own men* after three years in college courses and one in their own medical school but what we need is a uniform standard for a large number of colleges, a standard that forces full training in the essentials. We save a year and gain much.

"Since I am not a biologist, I leave the details of that subject to be filled in by the rest of you. The laboratory time is measured, not by any credit system, for that varies, but by actual required periods of work. The electives possible should not be permitted in science or mathematics. This insures a broader training. If we got a score or more colleges to agree to this arrangement we may persuade the American Medical Association to publish a list of 'Class A Plus Pre-medical Colleges.' Why not?"

The following is Professor Holmes's schedule of the three years' work:

FIRST YEAR

Chemistry, General:—At least 72 hours of lectures. At least 144 hours of laboratory.

Physics:—Same as chemistry.

German:—At least 144 lectures.

Mathematics:—Algebra and trigonometry, at least 72 hours.

Rhetoric:—At least 72 hours.

SECOND YEAR

Chemistry:—Must include some qualitative and quantitative analysis. At least 72 lectures and 144 hours laboratory.

Biology:—Similar to chemistry.

German:—At least 108 lectures.

Elective:—108 hours outside science and mathematics.

THIRD YEAR

Chemistry:—Must include organic: lectures, 72; laboratory, 96 hours; any other chemistry laboratory, 48 hours.

Biology:—Similar to chemistry.

French:—144 hours.

Elective:—108 hours outside science and mathematics group.

Note.—Hours refer to the entire year. The above is merely the minimum and in many cases could be increased slightly.

The results of the correspondence are interesting, not so much because so many institutions responded, as on account of the nature of the responses. As is usual in such instances those who were really interested continued the discussion, the uninterested dropped it. This again is of interest because evidently from the letters, there are some very much needed reforms.

One institution took faculty action on the resolution, and returned the following:

Be it resolved, etc.,

1. That we are glad, in so far as it is possible, to arrange our courses in biology, chemistry and physics so as to meet the admission requirements of the best medical colleges. That we are now doing this is evident from the fact that our graduates are readily admitted to the medical school of Johns Hopkins University.

2. That we will cooperate with the medical schools in every way practicable to eliminate duplication of work in college and medical school whenever such duplication exists.

3. That we do not regard a year in a medical school as having the same purpose or being in any sense equivalent to the senior year in college; that we regard the two fields of education as essentially different and distinct. We are therefore opposed to any plan whereby the bachelor's degree shall be given upon the completion of less than four years of college work.

One would only remark in commenting upon

this resolution that it all depends upon what the senior year is devoted to, whether it is or is not equivalent to a year in medical school. The senior year at Purdue in the course leading to the "B.S. in Science" is the equivalent of a medical college year and not "essentially different or distinct." Also, one might suggest that the meaning of equivalent should be stated if the paragraph is to be forceful. Moreover we shall point out later, the main difficulty in duplication is not between college and medical schools, but between college and high schools.

Other responses have come from presidents of institutions. Between these there is a world of difference. One is as follows:

> The National Educational Association has a committee out on this question [reform of the whole system of public schools]. It would be undesirable for the medical schools to take any definite action in conflict with the recommendations of this committee, or with the action of the N. E. A. I think that the best we can do at the present time is to accept the public school system as it is and build on it. Referring to the recommendations of Professor Holmes, of Earlham College, I beg to say that I do not believe that it is desirable to attempt to tie down colleges as to the character of their work for their degrees; I think the colleges would resent any attempt to impose such uniformity on them. I think, further, that the consensus of opinion at our conference, including the opinion of Dr. Welch, was that such stereotyped uniformity was undesirable. No two men would probably agree on exactly the relative distribution of time between the various subjects, or on the most desirable choice of subjects themselves. I, therefore, think it will be wise to keep out of the way of such complications and difficulties that would beset us if we attempted such uniformity.

The writer of this letter misunderstands Professor Holmes schedule, which was suggested as the form of a course. In carrying out such a scheme no limit is placed upon the individuality of teacher or student. The "relative distribution" of time is one thing, the essentials of premedical teaching is another. There is a *least* time in which the essentials can be covered by the average student and the schedule is made for the average. Allowance is always, I hope, made in colleges at least for the brilliant students for whom no schedule can ever be made.

Another presidential letter follows:

> I will answer first the questions formulated by your committee.
>
> 1. We offer everything required in the regular premedical course, that is, we fulfill the two-year requirements of the American Medical Association and besides this have just adopted an agreement with Western Reserve Medical College for a combination course—three years at our own school and four years at Cleveland.
>
> 2. I believe that the only way in which uniformity of essentials in premedical training can be obtained is by the adoption by the American Medical Association of standard requirements for a three-year course. Our faculty believes that the course suggested by Professor Holmes, of Earlham College, is an excellent one with possibly one or two minor additions. We are, at present, giving everything in this course and should be glad to publish in our catalogue a regular three-year premedical course if sanctioned by the Medical Association.
>
> 3. Our faculty believes that duplication of work is practically unavoidable in view of the quality of teaching done in certain secondary schools in the country. We believe that the best way to get efficient teaching in these schools so that work done there need not be duplicated in college is to increase considerably the requirements for those who wish to teach in such schools. Our idea is that the present system of examination required of teachers in many subjects tends to an unwise dissipation of energy on the part of the candidate. We should advise much stricter requirements in that particular line in which the candidate wishes to teach, with a thorough examination, and, at the same time, elimination of a dozen or more odd subjects now required in Ohio teachers' examinations. We believe that this method would make for the securing of well-prepared specialists in the various departments of secondary schools.
>
> 4. As stated above, we have made formal arrangements for a combination course only with Western Reserve Medical School. We are, however, prepared to enter into the same combination with any school in the A plus class of the American Medical Association. Our requirements are: Three years spent in residence at . . .; the pass-

ing of at least 96 semester hours of work here, with a total of 128 hours for graduation; also the completion of the necessary major and minor requirements in any of the courses laid out in our catalogue. If these conditions be satisfied, we will give a Bachelor's degree to students in combination course after one year's work in an A Plus Medical School.

I proceed now to answer your second letter containing the course of study proposed by Professor Holmes, of Earlham College.

I may say at the outset that our faculty is heartily in sympathy with Professor Holmes's ideas and believes that the establishment of a definite premedical course with a list of approved premedical colleges would be of extreme value.

As stated in answer to your first letter, we are perfectly willing to adopt combination courses giving a college degree after three years spent with us and one year in an A plus medical school, provided that the student has three years of residence in . . .; passes 96 hours of work here and a total of 128 hours for graduation and provided also that he fulfills the major and minor requirements of one of our regular courses. We already have made such an arrangement with the Western Reserve Medical School.

Our faculty begs to signify its approval of a three-year schedule as submitted by Professor Holmes with the following suggestions: That the various colleges be allowed a certain latitude as to the year in which certain subjects are given. Our courses in physics, for instance, are not open to freshmen and could not be taken in the first year. Possibly a general statement of requirements in each subject would meet more general approval than a definitely laid out program year by year and would allow various colleges a little more latitude in arranging courses. Our faculty is also unanimous in its feeling that at least 108 semester hours of psychology should be required in every premedical course, since this subject is practically indispensable to a well-equipped medical man of to-day.

With the above suggestions, we are heartily in agreement with the proposed plan and are willing to adopt it should it receive the sanction of the American Medical Association.

In this letter the quality of teaching in the secondary schools is mentioned. This I shall comment upon later. I wish, however, at this point to emphasize the method suggested for improving the teaching ability and therefore the quality of the teaching in secondary schools. The question of psychology is also touched upon. Certainly a course in psychology should be a prerequisite for graduation in medicine. Without it there is little value in courses on mental diseases, but any introductory course should be supplemented later by a brief course in experimental psychology, and, for those who desire to go more deeply into psychiatry, a thorough course should be offered.

Among the letters which have been received, there are two from deans which deserve quoting. The first begins with an outline of the work offered for the degree B.S. It then says:

We have had one case granted the privilege of being absent during the senior year, counting the work of the medical college as equivalent to our senior work. It did not appeal to us very strongly for several reasons. First, the difficulty of getting the reports of standing at proper times and controlling thesis work. This, of course, was a minor difficulty, but none the less annoying. Second, was the fact that high-grade students are not as a rule interested in such a scheme. With us it has apparently applied to an unstable group of students, restless under university restrictions and apparently constitutionally unable to remain in any institution for more than a year or two. Such men are neither good representatives of the college from which they go nor desirable candidates for the medical college in which they matriculate.

May I suggest another possible solution? Suppose we realize that four years is not a divinely appointed length of time for either baccalaureate or medical degree. Suppose we recognize the fact that the degree represents a definite amount of work satisfactorily done. Suppose that we also allow men of sufficient mental strength, industry and eagerness to do the work in three years, either in the college or in the medical school. If this were done, would not the same, if not a better, result be reached? Certainly high-grade men would be rewarded for their ability and industry and a short cut to two degrees would not be offered to all sorts of candidates. Whether in university or in medical college there seems no good reason why a man should not have one or two ways of obtaining credit, either by taking the subject or by examination.

As it stands, all of our courses of study are arranged for the average man, and the average intellect of five hundred people does not come very high. An easy inference is that many bright men, both in the university and in the medical college, are merely marking time. A method such as I suggest has nothing against it save the sanctity we have thrown around the four-year idea of the amount of work required for a degree. If requirements for a degree were measured in quantity and quality of work, instead of in time, many of the difficulties of which we complain would disappear.

I have no sort of objection to the plan as outlined. It is substantially that put in practise in 1895 by a number of institutions maintaining premedical courses by private arrangement with medical colleges. I will present the communication to the faculty for consideration and action, but I doubt if we would care to advertise a three-year-in-and-one-year-out-degree. That a baccalaureate degree should not be given for work done *in absentia* is almost a necessity if the degree is protected.

A scheme which will give the man of exceptional ability a chance would appeal to me. At present our educational systems favor the average man and penalize the exceptional man. We spend too much time trying to put a polish on a buckeye which should be given to mahogany. However, count on me to attempt to put anything through the committee agrees upon. I feel it is about time we are getting down to fundamentals in this joint between university and professional schools. If the fundamentals are not such, then what I have said is without significance; but being in close contact with medical and university education makes me absolutely certain that any attempt to shorten the time before the degree of M.D. can be secured, by elimination of English and other cultural studies, is basically wrong and foredoomed to failure.

This letter is to me an exceptionally strong one, for I feel that it hits the nail exactly and evenly on the head. The "divinely appointed length of time" occupied in the various divisions of an individual's educational career needs consideration. Let us by all means measure a man first by the quality of his work, and second by the quantity, and then help him in the way he should go, and if he deserves it, if he is mahogany—polish him; if he is a nut—give him what polish we can spare from the finer work, or plant him in another soil.

The second letter that I wish to quote in this connection is from a medical dean of a university where two courses are offered in preparation for medicine, a one-year and a two-year course, the latter loading with additional medical years to the degree B.S. This letter says that when conditions change, they in that university are prepared to make a rearrangement which will, the dean believes, be an improvement. And further,

The most serious problems with us arise from the inefficiency of the high schools, especially in the elementary science and language courses. So few of our high schools (and I think the conditions are essentially the same throughout the greater portion of the South) give acceptable courses in science and modern languages that for practical purposes they may be left out of consideration. The result is that the college courses must necessarily be more elementary in character and of lower grade than they otherwise should be. A course in general chemistry, for instance, arranged for students who have had in the high schools an elementary course in general chemistry with laboratory work would be of a much higher grade than a course arranged for students without such preliminary training. So long as this condition exists there will be very little improvement in "chemistry 1" or "zoology 1" or "physics 1." The weak elementary courses strike at the foundations of a sound science training and so long as chemistry 1 is weak, chemistry 2, 3 . . . x will not be all that we expect of them. The problem with us is therefore the strengthening of chemistry 1.

In the absence of adequate high school courses one obvious remedy is the introduction into the college curriculum of a group of elementary science courses supplementary to the high school course. This has been done in the modern language department here. Such an alternative will necessitate an additional "college year" which for many reasons is objectionable. The college should do less rather than more of the high school work.

This letter calls attention to the fact that high schools offer courses in physics, chemistry and biology, and that they offer incomplete courses, which, however valuable they may be to the individual who is not going to study medicine, waste the time of the one who

is going to. The remedy is obvious. The high school should limit its incomplete scientific work for the many who do not expect to follow scientific courses in college, and either offer complete courses for those who do expect to do scientific work, or leave the introductory science to the college. Such a program would mean a certain amount of individual work along the lines of vocational guidance, a thing which is being done more and more in preparation for the trades, and with excellent results. It has not been applied to the professions. As the age of graduation has increased it has become evident that some method must be devised which shall save the time of the student in order that he shall be prepared for his life work before he reaches senility. I have already called attention to a possible method of applying guidance methods to premedical students in high school and grammar school, but so far as I know the experiment has never been made.

There is a method which might be used certainly in college and even in high school. My attention was called to it by my colleague, Professor Fischer, who designated it as the Missouri plan. It is based upon a system which allows a student who does excellent work in a subject additional credit. The following extract from the University of Missouri Bulletin 1913–14 will elucidate the method:

> In order to encourage students to do the best work of which they are capable, the faculties of the college of arts and science and of the school of education credit their work in proportion to the grade received, thus enabling the most industrious students to *graduate in three years*. For each recitation hour for which the grade of excellent is recorded, the student will receive thirty per cent. additional credit. For each recitation hour for which the grade of superior is recorded, he will receive fifteen per cent. additional credit towards graduation.
>
> The faculty further recognizes that those students who are inferior to seventy-five in a hundred, but whose work is not estimated by the teacher as a complete failure, are entitled to some credit. Students will, therefore, be given four fifths of the normal credit towards graduation for each recitation hour for which the grade of inferior is recorded.
>
> In order to do entire justice to the needs of the students coming to the University of Missouri, the faculty adopts the method of instruction to the students of average ability. Those who are of somewhat less ability will thus receive some benefit from the instruction and some credit. Those who are of superior ability and will devote their best energies to their work will accomplish much more than the average student, and will be given for this, not empty honors, but recognition of their accomplishments by additional credit.

There is one letter which attacks the general elective system. In this letter the writer says that he has been opposed to the free elective system. His "contention has been that the undergraduate should be free to select his own aim, such as law, medicine, commerce or engineering; but that we should prescribe the program of work for its attainment." "Your letter," this professor says, "gives one a new incentive for a renewal of the contest; but this time for a three-year program."

Personally I believe in this stand on the subject of electives. I believe there should be a very definite program outlined for each student who has chosen his field—not a time schedule, but a subject schedule—in which there shall be some space for electives. And I believe, as I have said elsewhere,[1] that the earlier in the educational career of a student this schedule can be put in force, the better. There is too much to be known in all professions to waste time in indeterminate grazing.

The letters from professors, all from heads of departments, are as strong as those already quoted. In almost every instance the writers insist upon thoroughness and upon essentials rather than time consumed. Every one insists (though indirectly in certain cases) that three years of college work is the least in which the average man can obtain the essentials of medical preparation and the other things which, while not essential for medical practise, are essential for breadth and wide understanding. It was this thing that I have called breadth which made our fore-

[1] *Lancet-Clinic*, 1914.

runners in medicine what they are to us. Without a wide and deep social vision the doctor of the future will not be what he should be. Medicine is becoming more and more social. Its function is becoming more and more one of prevention. And a deeper insight into human nature, and a keener understanding of all the sciences, particularly the biologic, will be demanded of the man who will succeed.

PAUL G. WOOLLEY
UNIVERSITY OF CINCINNATI

PROFESSOR THEOBALD SMITH AND A NEW OUTLOOK IN ANIMAL PATHOLOGY

THE recent announcement of an additional endowment to the Rockefeller Institute for Medical Research, for the establishment of a department of animal pathology, marks a far-seeing and helpful recognition of the importance of a phase of research now scantily supported, yet full of promise for the physical and economic welfare of mankind and the well-being of animalkind also. But as the success of such an undertaking is after all more a matter of men than of money, the news that the projected department is to be organized and conducted by Professor Theobald Smith, of Harvard University, is of the happiest augury.

Though long in the foremost rank of the notables of science in America, the work of Professor Smith has not often secured, or suffered, popular exposition. But he has had the uncommon satisfaction of seeing, many times, the lines of thought and research which he has opened lead sooner or later to far-reaching theoretical development and practical achievements.

Thus while Dr. Smith was yet a subordinate in the Bureau of Animal Industry in Washington, he had occasion to study the Texas fever of cattle, then the cause of great economic loss to the farmers and cattle-men of that as well as other states, and of countries the world over. He found at last that the disease was incited by a protozoan parasite so small that it found a spacious abode within the purlieus of a single red cell of the blood, which it ruthlessly destroyed.

Smith and Kilborne announced also that this piroplasma, as it was called, is conveyed from animal to animal through the intervention of a cattle tick in which the protozoan undergoes a developmental cycle upon which the perpetuation of its kind depends. They further learned that cattle recovered from the fever had become immune, and though well, might indefinitely carry the piroplasma in the blood and be a perpetual source of infection for cattle fresh from another district.

This surprising, unprecedented, and, as it seemed to many at the time, unnecessarily complex and rather preposterous mode of infection made good its claims, and Texas fever leads the line of infectious diseases in men and animals, in which some insect acts as intermediary host and sole conveyancer of infective microbes from their sources to fresh victims. Thus in malaria and in yellow fever it is the mosquito which is to blame, and its suppression in any country insures virtual emancipation from these diseases. Thus have Cuba and Panama been rescued, and the way is open for the control of other tropical infections in other lands. Thus also the infective agents of plague and typhus and other communicable maladies are harbored and dispersed by insects which are the vulnerable links in the chain of infection often most easily broken through sanitary control.

The story of all these practical achievements in disease prevention through the knowledge and control of insect pests, leads back twenty years and more to the hot and gloomy garret in Washington, then the laboratory of the Bureau of Animal Industry, and to Dr. Smith's parasitic cattle tick harboring its own invisible protozoan parasite. And Texas fever no longer exacts its toll from man or beast; or if it does it is the man's fault. These immune cattle, bearers of the, to them, innocuous parasite, head the procession of "carriers" of infective agents, in which humans are now known to hold a conspicuous place, and are the bugbears of preventive medicine to-day.

Almost as soon as Koch had shown the world how easily and accurately to cultivate bacteria, more than thirty years ago, in the very

earliest of the eighties, the laboratories got intensely busy in the search for new species of germs; and as fast as forms were discovered which incite disease, the knowledge of how they look and what they do and how they may be restrained or destroyed was turned to the service of man and beast.

But the researches were not long content to spy upon the performances of the germs. What the living threatened body does to protect itself against them when once they gain a foothold became a subject of wide and fruitful inquiry. So the facts and doctrines and guesses relating to immunity and to infection, either natural or acquired, came to the front.

Pasteur had got some wonderful results in the experimental conference of immunity to infection, by gradually adapting animals to disease-inciting germs, which were living, but whose virulence and potency had been artificially reduced. It was then supposed that only the subtle action of the living germ could conjure forth the remarkable protective power apparently created in artificial immunity. Many others were at work on these and kindred lines; Dr. Smith among them. But he noticed, and was the first with Salmon to announce in 1886, that animals could be immunized not only by living germs but by cultures of these which had been sterilized and every vestige of life destroyed.

This announcement did not seem to start even a ripple in the bacteriologic pool. But the thing was in the air. There were many busy workers, and sooner or later such a record helps more than is commonly realized another explorer who is heartened to find his pathway not quite untrod.

Very soon it had been shown that immunity to diphtheria may be secured in animals not only by the living germs, but by the sterile products of their life processes. Thus with the names of Loeffler, Behring, Roux, Yersin and many others, opens the story of diphtheria antitoxin and its marvellous benefactions to mankind.

And so again, every horse which is turned to the uses of suffering mortals and gets his dosage of sterile diphtheria culture broth for the manufacture of antitoxin, is but another exemplar of the principle which first crystallized in the light of the response which Dr. Smith's pigeons made to the sterile hog-cholera bacillus cultures, at that early day, close to the dawn of the bacteriologic era in biology and medicine.

Dr. Smith has devoted a great deal of time and energy to the study of diphtheria and other antitoxins, both as professor of comparative pathology at Harvard and as the director of the antitoxine and vaccine laboratories of the Massachusetts State Board of Health. As is the case with most acute observers in these uncharted fields of bacteriology and immunity, he has encountered many striking phenomena which the lore of the time had not satisfactorily classified or accounted for. One of these carries a little story.

When Ehrlich was in this country in 1904, Professor Smith called his attention to the singular fact that guinea-pigs which he was using to test diphtheria antitoxin, sickened and died upon being injected with normal horse serum several weeks after they had been injected with diphtheria antitoxin. Guinea-pigs usually do not mind normal horse serum at all. Such an extraordinary sensitiveness to normal serum, following earlier injections seemed something new and unaccountable, and when Ehrlich got back to Frankfort he gave the problem to Dr. Otto, who labored with it and presently wrote a paper on what—with an attitude of undismay toward stately adjectives that is characteristically German—he called the "Theobald Smithsche Phënomenon." Nowadays the yearly lists of the achievements of research in infection and immunity fairly swarm with studies on "anaphylaxis," a phase of immunity of which Professor Smith's guinea-pigs afforded one of the first recorded examples.

In the early days of bacteriology Dr. Smith called attention to the value of a bent glass tube, closed at one end, such as was already in use by the chemists, for the purpose of cultivating many types of bacteria and studying their biological characters. This is of especial value in the culture and study of the class of

bacteria known as anaerobic, whose activities are intolerant of the presence of oxygen. "Smith's culture tube" has long been held in high esteem in the outfit of the bacterial laboratory.

But as early as 1890, Dr. Smith called attention to the fact that anaerobic bacteria are exacting not only in their relations to oxygen, but in their food requirements also; and he suggested, and proved, that attention to the latter gave promise of important results in the study of this class of germs. He then, and has repeatedly, urged that the addition to the fluid media in the tubes in which such organisms are commonly grown, of small pieces of sterile animal organs, such as the kidney, fulfil the required nutrient conditions. The repeated hint remained practically unheeded for some twenty years. Then through its adoption Noguchi, at the Rockefeller Institute, was able for the first time to cultivate the spirochete which is the inciting agent of syphilis, as well as several others of its class which have hitherto resisted all the wiles and blandishments of the most accomplished bacteriologists, in the framing of the conditions of culture and the tender of food. With these cultures available Noguchi has made practicable and safe a test—the luetin test—for the most subtle and obscure forms of syphilis. Thus the way is now open for the more ready detection of this sinister disease, for the study on a solid basis of the conditions under which it is manifested; how its protean characters are determined; and what rational methods for its cure may be conducted. Similarly, scarcely more than a year ago, Flexner and Noguchi, by an adaptation of Dr. Smith's long ignored suggestion about the food requirements of anaerobes, have been led to the discovery of the nature of the virus of infantile paralysis, isolating it in cultures maintained through many generations and clearing the way toward a hopeful outlook for the prevention and perhaps the cure of this pitiful malady.

One of Professor Smith's striking achievements is the establishment, through long and patient studies, of a type of the tubercle bacillus which has become especially adapted to cattle and now is known as the "bovine type" of the tubercle bacillus. The delimitation of this organism and its differentiation from the human type have made possible a series of exact researches by others on the frequency of the occurrence of the bovine bacillus in man. And thus to-day those who are engaged in the long and stubborn fight against the spread of tuberculosis are on firm ground when they enter the field of meat and milk contamination, to determine the measures which must be taken to safeguard them at their source.

These are some of the landmarks in Dr. Smith's achievements during this quarter of a century of incredible activities on every hand, in the discovery of microbic disease incitants, of the things they do, and the reactions of those individuals of the higher sort who in the vicissitudes of life may become their hosts and their victims.

As the eye ranges over the stately bibliography which marks these years of Dr. Smith's scientific activities, it rests upon many titles with stories in them, of a period or a halting point, in the growing knowledge of disease and its incitants, upon which the author's wide range of thought, his unventuresome sagacity, and breadth of vision have cast helpful and inspiring light.

While Professor Smith gets down to the humdrum details of exact research and record when it is necessary—and it often is necessary in all the ups and downs of the common road of fruitful biological research—the quality which is perhaps most characteristic is the larger view impressed upon all his problems. The biological point of view, if the reader please, in which the individuality of the living thing Dr. Smith sees bears in every feature the marks of its heredity and environment. The tubercle bacillus, for example, is to him not something which has just happened, in the human and animal kind. The bacillus gets his day in court, and is as much a part of the scheme of things as is his more imposing host. What happens when they meet in a many-sided conflict of adaptation, and the problems which gather about it are to be

solved only by sustained attention to all its many aspects.

This larger vision, the ability to set the pace on a high plane, the capacity for work, the power of constructive leadership—these are the qualities which lead those who know Professor Smith and his achievements to rejoice that he is now to center his activities in a field so full of promise as is animal pathology to-day; and this with the opportunities which the Rockefeller Institute affords those who share its aims, to carry forward their chosen work unhurried and unhindered.

T. M. P.

SCIENTIFIC NOTES AND NEWS

Dr. S. J. Meltzer, head of the department of physiology and pharmacology of the Rockefeller Institute for Medical Research, has been elected president of the Association of American Physicians in succession to Dr. Simon Flexner.

At its annual meeting, held on May 13, the American Academy of Arts and Sciences voted to award the Rumford Premium to William David Coolidge for his invention of ductile tungsten and its application in the production of radiation.

The Franklin Institute, Philadelphia, on May 20, presented its Elliott Cresson medals to Dr. Edgar Fahs Smith and Dr. Orville Wright. Addresses were made on "Scientists from the Keystone State," by Dr. Edgar Fahs Smith and on "Stability of Aeroplanes," by Dr. Orville Wright.

Honorary degrees are to be conferred by the University of Glasgow on Dr. Archibald Barr, late regius professor of civil engineering and mechanics in the university; Colonel Sir William B. Leishman, F.R.S., professor of pathology in the Royal Army Medical College, and Sir Ernest H. Shackleton.

On May 4, a company of men and women, forest lovers, gathered in Harrisburg, at an informal luncheon, to present a testimonial to Dr. J. T. Rothrock on his retirement from the Pennsylvania Forestry Commission. There were sixty-five present, among whom were Governor J. K. Tener; Mr. John Birkinbine, president of the Pennsylvania Forestry Association; Mr. A. B. Farquhar, president of the Pennsylvania Conservation Association; Mr. J. Horace McFarland, president of the American Civic Association; President H. S. Drinker, of Lehigh University, president of the American Forestry Association; Mr. C. F. Quincy, chairman of the executive committee of the American Forestry Association; Professor J. A. Ferguson, director of the forestry department, Pennsylvania State College; Hon. R. S. Conklin, commissioner of forestry, Pennsylvania, and Dr. S. R. Dixon, state health commissioner of Pennsylvania. The governor presented in behalf of two hundred and fifty donors, a beautiful loving cup, and Mr. Farquhar, Dr. Drinker and Mr. Conklin spoke of Dr. Rothrock's work and personality. Dr. Rothrock spoke feelingly in reply.

At the annual meeting of the Boston Society of Natural History the following officers were elected for the ensuing year: *President,* Charles Sedgwick Minot; *Vice-Presidents,* Robert T. Jackson, Nathaniel T. Kidder, William A. Jeffries; *Secretary,* Glover M. Allen; *Treasurer,* Edward T. Bouvé; *Councillor for two years,* Alfred C. Lane; *Councillor for three years,* Thomas Barbour, Henry B. Bigelow, Miss Cora H. Clarke, William G. Farlow, George H. Parker, John E. Thayer, Charles W. Townsend, William F. Whitney. Reports were made on the work and progress of the year and an illustrated paper was presented by Dr. Hubert Lyman Clark on his experiences as a member of the Carnegie Institution's expedition to Torres Strait and the Great Barrier Reef of Australia. The two annual Walker Prizes, awarded for the best memoirs submitted on subjects in natural history, were voted as follows: a first prize of $60 to Miss Marjorie O'Connell, A.M., of the department of geology, Columbia University, for her essay on "The Habitat of the Eurypterida"; and a second prize of $50 to William J. Crozier, of Cambridge, for his essay on "The sensory reactions of *Holothuria surinamensis.*"

DR. ZENTARO KAWASE, professor of forestry in the University of Tokio, Japan, is in America to make observations in original forest areas, especially those in the southern Appalachian Mountains.

DR. E. L. EKMAN, assistant in the botanical department of the National Museum at Stockholm, recently visited the New York Botanical Garden for nearly two weeks on his way on an exploration for two years to Santo Domingo and the state of Pernambuco, Brazil.

MR. A. N. HALL has been appointed government curator of the ancient monuments of Rhodesia. His headquarters will be at Great Zimbabwe, but he hopes to spend four months of each year in examining or searching for other remains.

DR. A. G. WEBSTER, professor of physics, Clark University, gave on May 8 a lecture on "Sound and Its Measurements," before the Columbia chapter of Sigma Xi.

ON April 23 and 24, Dr. Oscar Riddle, of the Carnegie Institution, lectured before the Sigma Xi Societies of Indiana University and Ohio State University on "The Determination of Sex and Its Experimental Control."

HIRAM PERCY MAXIM lectured on "The Annihilation of Noise" and demonstrated the Maxim silencers before the Middletown Scientific Association at Wesleyan University on May 12.

PROFESSOR CHARLES H. HASKINS, dean of the graduate school of Harvard University, delivered the annual address before the Zeta chapter of Phi Beta Kappa and the student body of Oberlin College, on May 8, on the subject "The Medieval Scholar."

THE retiring president of the Geographic Society of Chicago, Professor Henry C. Cowles, gave on May 8 before the society an illustrated account of his observations and experiences in guiding a party of distinguished plant geographers through the western United States in the summer of 1913.

THE Halley lecture for 1914 will be delivered at the University of Oxford by Colonel C. F. Close, director of the Ordnance Survey, on May 20. Subject, "The Geodesy of the United Kingdom."

THE celebration of the seven hundredth anniversary of the birth of Roger Bacon will be celebrated at the University of Oxford on June 10.

MR. ROBERT KAYE GRAY, an electrical engineer, active in the promotion of scientific research in England, died on April 28, at Brighton, at the age of sixty-two years.

M. PAUL LOUIS TOUSSAINT HEROULT, known for his work with aluminum and the electric furnace, died on May 10, aged forty-one years.

THE Liverpool School of Tropical Medicine plans to establish a permanent laboratory in Sierra Leone for the purpose of carrying on research work.

THE old chateau at Les Eyzies (Dordogne) has been purchased by the French government and will be converted into a museum of prehistoric archeology.

Nature calls attention to an arrangement now established at the Royal Botanic Gardens, Kew, whereby a competent guide accompanies visitors on week days through the gardens and explains the objects of botanical interest. A small charge is made for the services of the guide, 6d. for each person attending a morning tour, and 3d. for each person attending an afternoon tour. The present arrangements are of the nature of an experiment, and their continuance beyond September next will depend on the extent of the public demand for the services of the guide.

WE learn from the *Journal* of the Society of Arts that preliminary steps have been taken for the establishment of an institute of oceanography for the study and exhibition of marine life and products at Ste. Adresse, a suburb of Havre, overlooking the Bay of the Seine. Plans for a handsome building, about 275 feet long and 40 feet wide, have been drawn up by a well-known Paris architect. It will be constructed in a park of 323,000 square feet. It is estimated that the building and equipment will cost about $150,000. It is hoped to have the building completed and opened in time

for the meetings of the scientific congress to be held in Havre in the autumn of 1914. The most interesting feature of the institute will be an aquarium which will offer instruction and entertainment to the inhabitants of Havre and the vicinity, as well as to the numerous tourists who visit the district.

The University of Chicago Press has assumed the American agency for the *Internationale Monatsschrift für Anatomie und Physiologie*, published at Leipzig by Geirg Thieme. Professor Robert R. Bensley, of the department of anatomy in the University of Chicago, has been made American editor of the journal. The University Press has also announced the addition of two journals to the list of nine it publishes in America for the Cambridge University Press, England. The journals are *Annals of Applied Biology* and *The Annuals of the Bolus Herbarium*, the former of interest to workers in entomology, plant disease, diseases of animals, and forestry, and the latter dealing with the flora of South Africa. In addition to these twelve journals of research for which the University of Chicago Press is the American agent, it now publishes itself sixteen other journals.

The department of archeology, Phillips Academy, Andover, Mass., has conducted research work in the state of Maine for a number of years. In June, it is planned to send an expedition of ten or eleven men from the headwaters of the St. John River to its mouth—a distance of over three hundred miles. The expedition will then proceed to the head of Mattawamkeag stream and travel south some fifty miles, and then explore the Upper Grand Lakes, the Lower Grand Lakes and the Ste. Croix basin. A side expedition will move eastward into central New Brunswick. The total distance traveled in canoes will be over six hundred miles. The object of the expedition is, so far as possible, to trace the limits of the so-called Red Paint Culture, and to map prehistoric and historic sites in the regions visited. Excavations will be undertaken where it seems advisable. In case large or important sites are discovered the expedition will work out such in more or less detail, and if necessary, will postpone further reconnaissance until next year. The archeological material discovered, together with observations on historic sites, should enable students to better understand the relationship between the various eastern cultures, and may shed some light on prehistoric migrations. The plans have been approved, and in the absence of the director of the department, Dr. Peabody, in Europe, Curator Moorehead will conduct the expedition. Most of the members of the survey have seen previous service in Maine, and it is hoped that important results will be obtained. Francis B. Manning, of Harvard, will be first assistant; and Ernest Sugden will act as surveyor. The total number of Indian sites mapped by the department in Maine in past years is over two hundred. About 5,300 stone and bone artifacts have been taken from excavations at various points. The department is compiling a bibliography of references to Maine Indians. At present there are over three hundred titles, and the work is not completed.

Dr. J. E. Wallace Wallin, who since the winter of 1912 has occupied the position of professor of clinical psychology and director of the psychoeducational clinic in the school of education of the University of Pittsburgh, has been appointed to the position of director of the psycho-educational clinic in the St. Louis public schools. The clinic will be organized at the beginning of the next school year. It will be located on the grounds of the Harris Teachers College, with which institution it will be closely affiliated. Lecture courses on abnormal children by the director will be offered in the extension division of the college. Students may matriculate in these courses whether or not they reside in the city of St. Louis. The clinic will be organized as an independent bureau in the educational division of the school and not as a minor division of the department of school hygiene or medical inspection. But it will work in close cooperation with the latter department. The clinic will exercise administrative control under the regulations of the superintendent's office over the examination, classification, education,

placing and transfer of the mentally exceptional children in the public schools. The actual supervision of the work in the special classes will be done by a special supervisor working under the direction of the clinic. St. Louis has already segregated about 500 pupils in special classes, and it is expected that the number will now rapidly be increased to at least 1,000. Each child will be given a psychological, sociological, pedagogical, hereditary and medical examination. It is expected that a staff of assistants commensurate with the growing needs of the clinic will gradually be organized, and that, eventually, the clinic organization will include a bureau of vocational guidance. The clinic aims to serve as an educational, social and vocational clearing house for the community. The St. Louis authorities have carefully studied the situation and believe they have effected the best form of organization, linking the clinic, on the one hand, with the training school for teachers, and, on the other hand, making it an integral part of the educational division, with supervisory control of the special classes.

ALMOST every conceivable use to which land may be put is represented in the permits reported by the forest service for special projects on the national forests. Some of the uses shown range, alphabetically, from apiary through brickyard, cannery, cemetery, church, cranberry marsh, fox ranch, marine railway, rifle range and turpentine still, to wharf and whaling station. There are 15,000 permits in force for such special uses, which are distributed geographically from Alaska to the Mexican line, and east to Florida. This figure does not include any of the 27,000 permits in force for grazing cattle and sheep on the forests; nor the 6,000 transactions for the sale of timber, and the more than 38,000 permits issued last year for the free use of timber by settlers, miners and others in developing their homesteads and claims; nor the nearly 300 permits for water power development. California led all the national forest states in the number of these special use permits, followed by Arizona, Colorado, Montana and New Mexico in the order named. The largest single class of permits was for special pastures or corrals, to be used for lambing grounds, shearing pens, and the like. Next came rights of way for conduits, ditches and flumes, practically all of these being free. Various agricultural permits come third, telephone lines fourth with more than a thousand permits for 6,500 miles of line, and drift fences for the control of grazing animals, fifth. In both of these latter classes, too, practically all of the permits are free. Reservoirs for which more than 600 free permits were issued for the occupation of more than 100,000 acres come sixth. The rest of the uses are not classified though there are a large number of apiaries, camps, summer hotels and schools. The use of the government's lands for schools is given free; for hotels a charge is made. The principle which governs the charge is based, according to the forest service, on whether or not the use of the land is sought by the permittee for a commercial purpose. If it is the intent of the user to make money from a resource which belongs to the whole people, the service holds that he should give a reasonable return for that use. If, on the other hand, farmers want to use government land for their own telephone lines, irrigation works and schools, the government gives them that use without cost.

INTEREST attaches to the study of the fossil floras of the Arctic regions, for they indicate climatic conditions very unlike those now existing there. In place of the present almost perpetually frozen soil which supports but a handful of depauperate plants, the conditions from at least late Paleozoic to middle Cenozoic geologic time made possible at least during certain periods, an abundant and luxuriant vegetation, consisting of ferns and palm-like plants that could grow only in a mild and probably frostless climate. Although these lands are now so inhospitable, and hence but rarely visited, an astonishing amount of information concerning their fossil floras has been accumulated, and to this knowledge Alaska has contributed its full quota, says F. H. Knowlton, a paleontologist of the United States Geological Survey, in a short paper on the "Jurassic Flora of Cape Lisburne," just published as Part D of Professional Paper 85.

The fossil plants described by Mr. Knowlton were collected by A. J. Collier, a geologist of the Survey, while engaged in the study of the coal resources of the Cape Lisburne region. The coal deposits are extensive and are the only mineral resources of the region known to be of commercial importance. A little mining has been done by vessels short of fuel, which occasionally lie off shore and load on a few sacks of coal. This, however, is a rather dangerous practise, as there is no harbor. Cape Lisburne is the bold headland which marks the northwestern extremity of a land mass projecting into the Arctic Ocean from the western coast of Alaska between latitudes 68° and 69°. It lies 160 miles north of the Arctic Circle, about 300 miles directly north of Nome, and is the only point in Alaska north of Bering Strait where hills above 1,000 feet in height approach the sea. The Jurassic section to which the name Corwin formation has been given is said by Collier to consist of shales, sandstones, conglomerates and coal beds. Fossil plants occur in the shale beds wherever they have been examined. This formation reaches the enormous thickness of over 15,000 feet and contains 40 to 50 coal beds which range in thickness from 1 or 2 to over 30 feet, ten of them being 4 feet thick and suitable for mining. The various beds aggregate at least 150 feet of coal. Mr. Knowlton correlates the Jurassic flora of Alaska with that of eastern Siberia and concludes that the land connection between North America and Asia at this early period of the world must have been practically continuous. In reviewing the character and geographic range of Jurassic floras, especially as developed in Arctic and Antarctic regions, he states that the wide areal distribution of Middle and Upper Jurassic floras has long been one of the marvels of plant distribution. The living flora of to-day, of course, affords many individual examples of wide distribution, such as those found throughout the tropics of both hemispheres, and others, chiefly weeds, that have, largely through human agencies, spread widely over temperate lands, but altogether these plants form but an insignificant part of the whole flora, whereas in Jurassic time a large percentage of the whole flora was practically world-wide in its range. Even Cape Lisburne is by no means the northern limit of this nearly tropical vegetation; it has been found, preserved in the rocks, 180 miles northeast of Cape Lisburne.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. Helen H. Le Fevre has made to New York University a gift of $10,000 in memory of her husband, the late Dean Egbert Le Fevre. The gift is in the form of a trust to be known as the Dr. Egbert Le Fevre Deanship Fund.

The trustees of the University of Chicago have announced the appointment of a committee to decide on the date and character of the celebration of the twenty-fifth anniversary of the founding of the University. The University of Chicago was incorporated on September 10, 1890.

The New York State College of Forestry has announced plans for the establishment of a course in paper and pulp making.

It is stated in *Nature* that the British chancellor of the exchequer in explaining his budget proposals said that the education grant is to be reconstituted on the principle of making a distinction between the richer and the poorer areas, and between the areas that spend much and those that spend little on education. The increased cost of the exchequer of the education grant will be £2,750,000, but this year the grant will be confined to the necessitous school areas. The government is to contribute one half of the cost of the feeding of hungry school children, and also to make grants for physical training, open-air schools, maternity centers and technical, secondary and higher education. Referring to these grants, Mr. Lloyd George said: "The grants for technical, secondary and higher education are to make it more accessible to the masses of the children, and to extend its sphere of influence where children show any aptitude to take advantage of it. We compare very unfavorably with Germany and the United States of America in this respect.

There there is adequate provision for technical training, secondary and higher training for every child who shows any special gift for taking advantage of it, and I consider that this fact is a greater menace to our trade than any arrangements of tariffs."

AT Cornell University Assistant Professors O. A. Johnson and M. F. Barrus have been promoted to full professorships in the department of entomology and the extension department of plant pathology, respectively.

AT Hamilton College Professor Nelson Clark Dale, assistant professor of geology at Princeton University, will succeed Professor W. J. Miller, who goes to Smith College.

MR. C. G. DARWIN, eldest son of the late Sir George Darwin, has been appointed mathematical lecturer at Christ's College, Cambridge.

DISCUSSION AND CORRESPONDENCE

TWO UNDESCRIBED SPECIMENS OF CASTOROIDES OHIOENSIS FOSTER FROM MICHIGAN

THERE are two specimens of *Castoroides ohioensis* in the collection of the museum of geology, University of Michigan, that were found in the state and have not been recorded. One of these was discovered near Owosso, Shiawassee County, in December, 1892, by A. G. Williams. It is represented by the base and upper part of the right mandible with the incisor and all of the molar teeth in position, the base of the left mandible, and the left incisor tooth. The incisors are well preserved and show the longitudinal striæ and cutting edge, but the tip and base of each are broken. The row of molar teeth is 75 mm. long.

The second specimen, a skull without the mandibular bones, was exhumed in a tamarack swamp in Pittsfield township, Washtenaw county, by J. B. Steere, in 1902. It was lying on a bed of gravelly marl and beneath three feet of peaty soil. The skull is hard, of a rich dark brown color, and is little damaged. The left zygomatic arch is broken, and the teeth, with the exception of the last molar on the left side and the right incisor tooth, are missing. Nearly the full length of the right incisor is represented, the only damage to the tooth being an injury to the outer surface and the loss of a few millimeters from the base. The double nature of the internal nasal orifices is well shown. The measurements are as follows:

	Mm.
Length of skull from occipital angle to forward end of nasals	280
Length of skull from occipital angle to forward end of maxillaries	293
Width of skull across occiput	168
Width of skull across zygomatic arches	230
Height of skull at occiput	68
Height of skull at last molars	98
Length of nasals	116
Greatest dimensions of zygomatic arch	67 × 115
Width of occipital foramen	36
Length of molar tooth row	73

The writer is indebted to Professor E. C. Case, of the department of geology, University of Michigan, for permission to publish these records.

NORMAN A. WOOD

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SCIENTIFIC BOOKS

Outlines of Chordate Development. By WM. E. KELLICOTT. New York: Henry Holt & Co. 1913.

In this volume Professor Kellicott endeavors to give a compact though comprehensive account of the development of the Chordates, such as will be suitable for the student of general embryology. For this purpose the frog is taken as representing the type, or rather, one should say, the mean, of chordate development, and a full and connected account is given of its early development and organogeny. This account is, however, preceded by an excellent statement of the embryology of *Amphioxus,* the author believing that whether or not this represents a truly primitive type of development, "it affords, in simple diagrammatic style, the essentials of early Chordate development," while its specialized later stages "may serve to put the student upon his guard

against a too exact phylogenetic interpretation of embryological facts." While admitting the correctness of the first of these statements, from the point of view of the student seeking an outline of the principles of Chordate development one may question the pedagogical propriety of adding a number of more or less irrelevant facts for the purpose of enforcing a conclusion which may be deduced with even greater clearness from the more pertinent embryological phenomena of the higher chordates.

Following the account of the frog, the early development and organogeny of the chick is considered, and the book ends with a chapter on the early development of the mammalia, special attention being devoted to the development of their embryonic membranes and to that of the external form of the human fetus. It is unfortunate for the continuity of the descriptions that no mention is made of the early processes of development of the Reptilia, since these in several particulars afford a much clearer transition to the specialized mammalian conditions than do the similar stages of the chick. The account of the later stages of *Amphioxus* might well have been replaced by a description of the early stages of reptilian development.

But, on the whole, Professor Kellicott's book is an excellent one, both in its conception and execution. The descriptions are clear and without redundancy and are illustrated by numerous well chosen illustrations. Extensive bibliographic lists are appended to the various sections and there is an excellent index.

J. P. McM.

Chemical Technology and Analysis of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. In three volumes. 5th edition. Volume I. Macmillan Company. 1913. $6.50.

This volume has increased from 542 to 668 pages: the chapters on the Constituents and on the Examination of the Mixed Fatty Acids being increased by nearly one third. In view of the encyclopedic character of the book, one is surprised to find no mention of the absolute viscosimeter; of Dunlap's excellent method of purifying alcohol for alcoholic potash; of T. W. Richards' apparatus for distilling in vacuo by electricity, all of which are admirably adapted for work with fats and oils. The information regarding the Saybolt viscosimeter, too, is not the latest, although perhaps the latest published.

The reviewer regards the treatment of the subjects as most thorough and eminently satisfactory. It is wisely critical, showing evidence of investigation done under the doctor's own eyes. It is approached by nothing in any language, as is attested by the fact of its translation into French and rewriting in German. It is invaluable to every one having to do with fats, oils and waxes.

It will be noted with deep regret by all in this branch that the appearance of the book in this country closely coincided with the death of its author.

A. H. Gill

SCIENTIFIC JOURNALS AND ARTICLES

The April number (Vol. 15, No. 2) of the *Transactions of the American Mathematical Society* contains the following papers:

Maurice Fréchet: "Sur la notion de différentielle d'une fonction de ligne."

J. H. M. Wedderburn: "A type of primitive algebra."

C. T. Sullivan: "Properties of surfaces whose asymptotic curves belong to linear complexes."

E. W. Chittenden: "Relatively uniform convergence of sequences of functions."

H. S. Vandiver: "Note on Fermat's last theorem."

E. R. Hedrick and Louis Ingold: "A set of axioms for line geometry."

G. C. Evans: "The Cauchy problem for integro-differential equations."

The March number (Vol. 20, No. 6) of the *Bulletin of the American Mathematical Society* contains: Report of the twentieth annual meeting of the society, by F. N. Cole; Report of the winter meeting of the society at Chicago, by H. E. Slaught; "Shorter Notices"; Zoretti's Leçons sur le Prolongement analytique and Scheffers's Serret's Lehrbuch der Differential- und Integralrechnung, by Frank

Irwin; Meyer's Theorie benachbarter Geraden und ein verallgemeinerter Krümmungsbegriff, by E. B. Cowley; Hilbert's Grundlagen der Geometrie and Grundzüge einer allgemeinen Theorie der linearen Integralgleichungen, by T. H. Gronwall; Lebon's Gabriel Lippmann, Moritz's College Mathematics Notebook and College Engineering Notebook, and Harris's Gravitation, by E. B. Wilson; "Notes"; and "New Publications."

THE April number of the *Bulletin* contains: "An unpublished theorem of Kronecker respecting numerical equations," presidential address, by H. B. Fine; "Two convergency proofs," by Arnold Emch; "Some properties of the group of isomorphisms of an abelian group," by G. A. Miller; Review of Landau's Handbuch der Lehre von der Verteilung der Primzahlen, by T. H. Gronwall; Review of Fisher's Purchasing Power of Money, by E. B. Wilson; "Shorter Notices"; Clebsch-Lindemann's Geometrie, by Joseph Lipka; Weyl's Die Idee der Riemannschen Fläche, by F. R. Moulton; "Notes"; and "New Publications."

THE May number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole; "A non-enumerable well-ordered set," by A. B. Frizell; "Note on the Fredholm determinant," by W. A. Hurwitz; "Time as a fourth dimension," by R. C. Archibald; Review of Bützberger's Bizentrische Polygone, Steinersche Kreis- und Kugelreihen und die Erfindung der Inversion, by Arnold Emch; "Shorter Notices"; Loria's Poliedri, Curve e Superficie secondo i Metodi della Geometria descrittiva and Darstellende Geometrie, zweiter Teil, by Virgil Snyder; Czuber's Differential- und Integralrechnung, by L. W. Dowling; Ciani's Lezioni di Geometria proiettiva ed analitica, by E. B. Cowley; Hessenberg's Transcendenz von e und π and Bolza's Variationsrechnung, by T. H. Gronwall; Picard's Das Wissen der Gegenwart in Mathematik und Naturwissenschaft, by J. B. Shaw; Sturm's Maxima und Minima in der elementaren Geometrie, by J. V. McKelvey; Norris and Craigo's Advanced Shop Mathematics, by P. F. Smith; Czuber's Wahrscheinlichkeitsrechnung, by H. B. Phillips; Lord Kelvin's Mathematical and Physical Papers, volumes IV., V. and VI., and Love's Problems of Geodynamics, by E. B. Wilson; Annuaire pour l'An 1914 publié par le Bureau des Longitudes, Combebiac's Les Actions à Distance and Abbe's Mechanics of the Earth's Atmosphere, by E. W. Brown; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE SYSTEMATIC POSITION OF THE MYLODONT SLOTHS FROM RANCHO LA BREA [1]

IN the excavation work carried on by the University of California in the Pleistocene of Rancho La Brea, a considerable percentage of the material obtained represents ground-sloths of the mylodont group. Twenty-seven skulls, representing the family Mylodontidæ, are now in the collection of the department of paleontology. Of these, nineteen are well preserved and show the dental series on both sides. Many lower jaws are also available, several of which are associated with the skulls. In a preliminary consideration of this extensive series of specimens, certain suggestions as to the relationship of some of the mylodont genera have presented themselves. It seems desirable, therefore, to make this information available for other students of the group.

The writer is indebted to Professor John C. Merriam for kind assistance during this study.

The genera *Mylodon* and *Paramylodon*, to which the Rancho La Brea material has previously been referred, are the members of the family Mylodontidæ definitely recognized in the North American Pleistocene. A fragmentary lower jaw, originally described by Harlan from Big Bone Lick, Kentucky, was referred to *Mylodon* by Owen in 1840. In 1903 Brown[2] established the genus *Paramylodon* on a skull and lower jaw with associated skeletal material obtained from Pleistocene deposits near Hay Springs, Nebraska.

[1] Read at the fifth annual meeting of the Paleontological Society, Princeton, N. J., January 1, 1914.

[2] Brown, B., *Bull. Amer. Mus. Nat. Hist.*, Vol. XIX., Art. XXII., pp. 569–583, 1903.

In 1909 Cockerell[3] briefly described a skull from Walsenburg, Colorado. Brown believed it to be distinct from *Paramylodon* and assigned it to the genus *Mylodon*. Some doubt as to the validity of the genus *Paramylodon* was subsequently expressed by Osborn,[4] though Allen,[5] in a recent paper, accepts the determination of Brown.

The diagnostic characters of the genus *Paramylodon* were stated by Brown as follows:

> Skull elongate; muzzle inflated; dentition $\frac{5}{4}$; first upper molar the largest of the series; last lower molar trilobate; first lower molar without opposing tooth.

The nineteen skulls from Rancho La Brea are similar to the Nebraska and Colorado specimens in the elongation of the head and the inflation of the muzzle. In several of the California specimens the teeth have fallen from the sockets, the study in such cases being restricted to the alveolar outlines. The series arranges itself as follows:

1. Four skulls with four teeth on both sides.
2. Six skulls with four teeth on one side and five teeth on the opposite side.
3. Nine skulls with five teeth on both sides.

The superior dentition varies, therefore, from four to five teeth on each side; and this variation appears to be independent of the age of the individual. It follows from the variable presence of the first tooth, that it is the second superior tooth which is the largest of the series. Upon the presence of the first superior tooth depends, also, the nature of occlusion with the first inferior tooth.

The fourth inferior tooth, in a series of five lower jaws, is most distinctly trilobed in an individual of the first group. The tooth appears slightly less trilobed in individuals of the second and third groups, and may be two-lobed in the last group.

Judging from the variation in the large series from Rancho La Brea, the form described by Brown, as well as the remains from the asphalt deposits, should apparently be placed in the genus *Mylodon*. The earlier authors would probably have arrived at a similar conclusion, had this extensive collection been available. Allen considers the Colorado skull as belonging to *Mylodon harlani* Owen. Possibly the specimens from Nebraska and Colorado are closely related specifically to the Rancho La Brea remains. At present the writer will only state that the inferior dental series of several mandibles from Rancho La Brea bear a close resemblance to the type specimen of *M. harlani*.

A third type of ground-sloth from North America, which has been considered with the Mylodontidæ, is the genus *Morotherium* described by Marsh[6] in 1874 from remains found in Alameda county, California. Marsh considered *Morotherium* closely related to *Mylodon* and *Megalonyx*. It was distinguished from *Mylodon* by the absence of the depression in the head of the femur for the ligamentum teres. The humerus of *Morotherium* differed from *Megalonyx* in the absence of the supracondylar foramen. In 1899 Merriam[7] described a humerus from Pleistocene strata near Tomales Bay, California. It resembled closely the known portion of Marsh's specimen and was referred to *Morotherium*, although the validity of the genus was questioned by the writer.

A comparison of the Tomales Bay humerus with several specimens from Rancho La Brea indicates that the former specimen undoubtedly belongs to *Mylodon*. The writer has not seen the type (femur) of *Morotherium*. As stated by Marsh, it resembles *Megalonyx* in general shape. The specimen, as figured, appears to be quite different in shape from the *Mylodon* femurs of the asphalt deposits. The absence of the notch for the ligamentum teres can hardly be considered as generically distinctive of *Morotherium*, as it may be absent

[3] Cockerell, T. D. A., Univ. Colo. Studies, Vol. VI., No. 4, pp. 309–312, 1909.

[4] Osborn, H. F., "The Age of Mammals in Europe, Asia and North America," Macmillan Co., p. 457, 1910.

[5] Allen, G. M., *Mem. Mus. Comp. Zool. Harv. Coll.*, Vol. XL., No. 7, pp. 319–346, 1913.

[6] Marsh, O. C., *Amer. Jour. Sci.*, Vol. 7 (3), Art. XLIX., pp. 531–534, 1874.

[7] Merriam, J. C., *Bull. Geol. Soc. Amer.*, Vol. 11, pp. 612–614, 1899.

on *Mylodon* femurs from Rancho La Brea. The femur of *Megalonyx*, as figured by Leidy, appears, also, to be without this notch. Possibly Marsh's type should be referred to *Megalonyx*.

CHESTER STOCK

PALEONTOLOGIC LABORATORY,
UNIVERSITY OF CALIFORNIA,
December 9, 1913

THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

WEDNESDAY, DECEMBER 31, 1913, TEN O'CLOCK

Soil Bacteriology

Bacterial Activities and Crop Production: P. E. BROWN.

The importance of correlating the results of bacteriological tests with known facts regarding soil fertility is emphasized. The improvements in methods for the bacterial examination of soils has made possible the study of the relation between bacterial activities and crops produced. Thus the determination of the ammonifying power, the nitrifying power or the azofying power of soils may be an indication of their fertility or crop-producing power, or at least of the relative fertility of several soils.

Soils under varying rotations and under different treatment have been studied during the past three years, and the results secured show in practically every case a similar, definite relation between the crops produced on the various plots and the ammonifying power and the nitrifying power of the soils determined by the fresh soil-casein method for the one and the fresh soil-ammonium sulfate method for the other.

It is evident that the bacterial activities in soils determine very largely the crop-producing power of the soils. If the bacterial mechanism which brings about the solution of insoluble plant food is inadequate, crops will suffer for lack of food. In soils where improper rotations and poor treatment is practised the conditions very quickly become unsatisfactory for optimum bacterial growth and crops immediately feel the effect of this diminished growth in a reduced supply of food. The work, as a whole, therefore, points toward the value of bacterial tests as a measure of the crop-producing power of soils.

The Environment of Soil Organisms: F. H. HESSELINK VAN SUCHTELEN.

Growing out of the importance of the action of media on organisms a study of soil as a cultural medium was undertaken. So far as our present knowledge concerning soils extends, the only means at our disposal for judging the cultural medium of soil organisms is drainage water. It may be expected, however, that the soil solution as it exists in the soil differs quantitatively from the drainage water.

A method was devised for obtaining this soil solution based on its displacement by inactive substances (paraffine oil, vaseline, etc.). Work by means of the determination of osmotic pressure and electrical conductivity was undertaken, which demonstrated the value of such a displacement.

The absolute amount of soil solution obtained by the above-mentioned method varied from 100–435 c.c. solution. As an example of the successful extraction the following data may be quoted. From 7.949 kilograms of sandy loam with a total water capacity of 24.6 per cent. containing 14.3 per cent. water (all figured on the basis of dry soil), there was obtained 330 c.c. of soil solution. The concentration of the soil solution bears a resemblance to the very first portion of drainage water obtained by careful percolation through a large quantity of soil.

Besides an extensive study of the soils employed in our experiments, there were made physico-chemical and chemical examinations of the liquid obtained by the foregoing displacement process, together with a determination of the number of microorganisms found by the plate method. It was ascertained that different soils, soils closely adjacent and the soils of different layers, contained soil solutions of different compositions. Detailed results will appear in a future publication.

A New Medium for the Quantitative Determination of Bacteria in Soil: H. JOEL CONN.

Three special media for soil work have been proposed during the last few years: by Hugo Fischer,[2] by J. G. Lipman[3] and by P. E. Brown.[4] Recently an asparaginate agar containing wholly chemicals of known composition has been prepared at the New York Experiment Station. A fifth medium, a soil-extract gelatin, has been compared with them, because it has been found to give a very high and regular count. The composition of these media are as follows:

[1] Abstract of papers presented.

[2] *Centbl. f. Bakt.*, II., Ab. 25, p. 457.

[3] *Id.*, 25, p. 447.

[4] *Id.*, 38, p. 497.

	Asparag. Agar	Fischer's	Lipman's	Brown's	Soil-Extr. Gelatin
Water	1,000	—	1,000	1,000	900
Soil-extract	—	1,000	—	—	100
Agar	12	12	20	15	—
Gelatin	—	—	—	—	120
Peptone	—	—	.05	—	—
Albumin	—	—	—	.1	
Na. Asparag.	1	—	—	—	—
Dextrose	1	—	10	10	1
$MgSO_4$	.2	—	.2	.2	—
K_3HPO	—	2	.5	.5	—
$NH_4H_2PO_4$	1.5	—	—	—	—
KCI	.1	—	—	—	—
$CaCl_2$	.1	—	—	—	—
$FeCl_3$	Trace	—	—	—	—
$Fe_2(SO_4)_3$	—	—	—	Trace	—

In the asparaginate agar the reaction should be carefully adjusted to 0.8 per cent. normal acid to phenolphthalein. The dextrose and asparaginate should be added just before tubing.

Some thirty-five comparative tests of the gelatin with one or more of the other media have been made. Various soils have been used for inoculating. Incubation has been at 18° C. for seven days with gelatin and fourteen with agar, which allows a very high count (5–50 million in normal field soil). The following figures (referred to in terms of colonies on asparaginate agar as 100) represent instances that seem to be typical:

	Asparag. Agar.	Fischer's	Lipman's	Brown's	Soil-Extr. Gelatin
Case 1	100	170	68	57	113
Case 2	100	85	75	Irregular	93

About forty other tests have been made to determine the best proportions of the various constituents in the asparaginate agar. None have proved more satisfactory than the above formula.

As a result of this work the asparaginate agar is highly recommended. The only medium which seems better, either in respect to count or to the colony differentiation, is soil-extract gelatin; and because of the addition of soil extract this gelatin is not one that can be readily duplicated. The only one of the media investigated which gives a higher count than either of these is Fischer's soil-extract agar, which does not allow good colony differentiation. The detailed results of this work are to be published as a technical bulletin of the New York Agricultural Experiment Station.

Antagonism Between Salts as Affecting Soil Bacteria: CHAS. B. LIPMAN.

With Loeb's conception of physiologically balanced solutions as a basis, the author has carried on experiments dealing with a phase of the subject hitherto regarded as of little significance, namely, the antagonism between anions. The most striking results have been obtained with such antagonism between anions through the use of the so-called alkali salts which commonly include sodium chloride, sodium carbonate and sodium sulfate.

Results of antagonism between the anions of these salts show that both as regards ammonification and nitrification, it was possible to improve the soil as a medium after it had been made toxic for the bacteria in question, by means of any one of these salts, through the addition of any other of the three salts mentioned. Thus briefly, it was possible at times to triple and quadruple the total salt content of the soil and still make it a better medium for ammonification and nitrification than it was with one third or one fourth of the total salt content consisting, however, of but one salt. The author claims for this great significance in the direction of the management and control of alkali land.

Sulfofication in Soils: P. E. BROWN AND E. H. KELLOGG.

Recent work has shown that considerably larger amounts of the element sulfur are removed from soils by the growth of crops than has been supposed. The inaccuracy of the old method used in the determination of the sulfur in crops explains the discrepancy. Soils have been shown to contain in most cases only a limited supply of sulfur, usually a smaller amount than of phosphorus. The problem of the sulfur feeding of plants is therefore coming to be of considerably more importance than it has been in the past. The natural means of returning sulfur to the soil is by the use of farmyard manure or green manure and in these materials it is added in a complex organic form in the proteins. The sulfur in these must be transformed into sulfates to be of use to plants.

Here is where the sulfofying bacteria appear. They are the agents which bring about the change of organic sulfur into sulfates. Many questions immediately arise in a consideration of this point. Do soils have a sulfofying power? Can this be determined? How? What is the relation of the sulfofying power of soils to the sulfur feeding of plants? etc. This work deals with the first question and shows that soils do have a definite sulfo-

fying power which varies with the type of soil, soil treatment, etc.

The sulfofying power of soils may be determined in the laboratory in the following way:

100 grams of fresh soil obtained with all precautions that it shall be representative and uncontaminated are weighed out in tumblers and thoroughly stirred. Then 0.1 gm. of a sulfide (Na_2S) or sulfur is added. Moisture conditions are brought up to the optimum by additions of sterile water. The soils are incubated for 4–5 days at room temperature. At the end of that time the sulfates are leached out by shaking for six hours with water in a shaking machine. The sulfate content of the soil itself is determined and the purely chemical oxidation of the sulfide occurring upon shaking the sulfide for six hours with the soil is also ascertained.

The sum of these two is subtracted from the total sulfate content of the soil after incubation and the difference gives the sulfofying power of the soil, or the physiological efficiency of the sulfuroxidizing bacteria in the soil. Many difficulties have been met in the work and largely overcome. Details regarding these will appear in a future publication. The point to be emphasized by the results so far is that soils have a definite sulfofying power which is determinable in the laboratory and therefore the efficiency of fertilization of soils with organic sulfur compounds may be ascertained for any soil.

Further Studies with Some Azotobacter: DAN H. JONES.

Viability of Azotobacter in Stock Cultures.—Equal quantities of azotobacter growth were taken from cultures grown on Ashby's agar for varying periods of time and plated out in beef gelatin. The relative colony counts were as follows:

Culture 16 days old	9,000 colonies
Culture 2 months old	8,000 colonies
Culture 5 months old	5,000 colonies
Culture 7 months old	4,500 colonies
Culture 1 year and 4 months old	2,200 colonies
Culture 2 years and 2 months old	60 colonies

This work was duplicated with the four varieties of azotobacter under observation with approximately same results.

Thermal Death Point of Azotobacter in Stock Cultures of Different Ages.—The cultures used for the viability test were tested for their thermal death point, by mixing one loopful of culture in 10 c.c. of Ashby's solution and then held in water bath for 10 minutes at the required temperature.

All cultures heated up to 55° C. gave good growth.

All cultures heated up to 65° C. and over gave no growth.

Involution Forms.—Involution forms of azotobacter varying very much in shape and size may appear in cultures grown in Ashby's solution and Ashby's agar at any temperature within growth limits. This tendency to produce involution forms is comparatively slight at 20°–25° C., but excessive at 37° C. Involution forms taken from an Ashby agar culture 2 months old were tested for their power to reproduce in Ashby's agar in moist chambers. Fifteen were held under observation for four days, but during that time only one reproduced. Normal cells present in the same fields produced colonies which overgrew the involution forms.

Azotobacter and Plant Growth.—It was decided to test the power of azotobacter to fix sufficient atmospheric nitrogen for plant growth. Special vessels were designed for the purpose. These were filled with well-washed quartz sand, sterilized, soaked with Ashby's solution and inoculated with azotobacter, controls being kept. After two weeks, grains of wheat were sown in the pots of sand. Those all germinated and gave growth-producing plants 16 inches high in one month, but no difference was observed at this time between the culture plants and the controls.

A Possible Improvement in the Technique of Determination of the Ammonifying Power of Soils: T. D. BECKWITH AND A. F. VASS.

One of the difficulties met with in determining the ammonifying power of soils is that part of the ammonia was lost under the older methods. We have found it possible to determine the total amount of ammonia given off by soils by a very simple method of laboratory technique. The soil, generally 100 or 200 grams in content, is placed in a 1,000 c.c. Erlenmeyer flask. In the top of the flask is inserted a two-hole rubber stopper. The air is allowed to enter the flask through the inverted U-tube. The outer tube is made of a simple elbow placed in the other hole of the stopper. This flask thus prepared is connected with a water pressure filter pump. In the series between the soil flask and the pump is placed a wash bottle containing $N/10$ H_2SO_4. For purposes of an indicator this acid solution is colored slightly with cochineal. When soil and the material to be ammonified is placed in the soil flask, air is drawn through the system by the filter pump. The ammonia is intercepted by the acid. The indicator in the wash bottle shows the point of neutralization.

When neutralized another wash bottle with an aliquot portion of acid is substituted. A final determination of the amount of ammonia in the soil flask plus that of the acid in the wash bottle shows the exact amount of ammonia given off. A large series of flasks and wash bottles may be served by the same filter pump, using appropriate connections of Y and T tubes with heavy-walled rubber tubing. It is necessary to use screw pinch cocks throughout the system in order to regulate the flow of air through the wash bottles and to see that none are cut off. Such a system should be used and adjusted for at least twenty-four hours before the soil and material to be ammonified are added in order to make sure that all is in perfect working condition.

A Bacterial Disease of the Larvæ of the June Beetle, Lachnosterna Spp.: Zae Northrup.

During the summer of 1912, the larvæ of the June beetle, *Lachnosterna* spp. committed serious depredations to crops. Specimens sent in to the entomological department by the farmers were found to be diseased and were turned over to the bacteriological laboratory for the determination of the etiology of the infection, and, if practicable, to use the living parasite as a remedial measure.

This disease which is characterized by a blackening of the affected parts, was found to be due to a micrococcus, which was found microscopically in smears and in sections from diseased tissue. This organism was isolated from the affected tissues of a living grub and liquid cultures were used for the inoculation of the soil in which healthy larvæ were then placed. Oftentimes infection occurred within a short time; the most marked infection occurred when an incision was made in the integument, a characteristic lesion developing within twenty-four hours. It was discovered that an excessive amount of water in such inoculated soil favored the rapid progress of the disease. This seems to be one of the most important factors in determining the fatality of the infection. This disease may be transmitted characteristically to larvæ of the southern United States June beetle, *Allorhina nitida* and to the American cockroach, *Periplaneta americana*, but is non-pathogenic to rabbits or guinea-pigs. The black pigment characterizing the disease is probably produced directly or indirectly by the activity of the bacterial cells within the larval tissues; the cocci and the integument cells in which they are imbedded do not take the ordinary or the Gram stain but remain dark brown in color. From the characteristic lesions produced by this organism it has been named "*Micrococcus nigrofaciens.*" No results have as yet been obtained in trying out this organism as a remedial measure for the destruction of the white grub. Cultures of the micrococcus have been sent to Porto Rico for this purpose.

Wednesday, December 31, 1913, Two-thirty o'clock

Sanitary Bacteriology

A Numerical Comparison of the Organisms Producing Gas in Lactose Bile Isolated from the Baltimore City Water Supplies: J. Bosley Thomas and Edgar A. Sandman.

The water supply of Baltimore city is derived from two streams which flow through a rather populous rural district. The larger stream, which has an average daily flow of about one hundred million gallons, drains a watershed supporting many large dairy farms, while the other, with a flow of twenty million gallons per day, is derived from a watershed supporting fewer dairy farms in proportion to its area, but known to be subject to a greater extent to possible sewage pollution. It, therefore, occurred to us that there might be shown in one of these supplies the presence of a different relative proportion of certain types of organisms than in the other supply; and a pollution derived largely from dairy-farms and creameries is obviously of a less serious character than a pollution caused principally by the introduction of sewage. For the classification of these organisms four sugars, in addition to the customary use of gelatin, were used, viz.: lactose, dulcite, saccharose and dextrose. Endo's agar was used for isolating the organisms in pure culture, and the results of a study of the character of colonies formed on this medium is given in the original paper. The average number per c.c. of the several types of organisms was estimated by considering the number of positive and negative tests in each dilution and following the method described by Phelps before the American Public Health Association in 1907. The results of this work, embracing 383 isolations from untreated water, show an average number of 2.79 organisms per c.c. giving cultural characteristics of *B. coli communis* and *B. coli communoir*, and 9.31 organisms per c.c. giving cultural characteristics of *B.* (*lactis*) *aerogenes* and *B. acidi lactici*, in the Gunpowder River, which is exposed to pollution from dairy-farms, in comparison with 5.12 organisms of the former types and 4.98 of the latter types in the Jones Fall supply, which is more exposed to sew-

age pollution. It is, therefore, seen that although the total number of these organisms is about the same in either supply, there are nearly twice as many *B. coli*-like organisms in the supply subject to greater sewage pollution than in the Gunpowder River.

Notes on the Bacteriology of Air and Its Sanitary Significance: C.-E. A. Winslow.

Both mouth spray and dust contain buccal bacteria and at times pathogenic forms, and might theoretically constitute sources of appreciable atmospheric pollution. Whether they actually do so or not can only be determined by quantitative studies of the bacteria actually present in air and particularly of the characteristic organisms of the mouth. Two sets of results bearing upon this point are here reported.

A series of 684 examinations of school room air in New York City made by Professor Chas. Baskerville and the writer gave an average of 96 microbes per cubic foot. This includes all organisms developing on litmus lactose agar in five days at room temperature. Two hundred and sixty-eight samples gave counts under 50, 178 between 51 and 100, 112 between 101 and 150, 39 between 151 and 200, 23 between 201 and 250, 12 between 251 and 300, and 17 over 300. Lactose fermenting streptococci (characteristic buccal forms) were found 52 times in 174 cubic feet of air giving an average of 30 per 100 cubic feet of air.

The second series of results includes 64 samples of outdoor air (mainly from New York City streets) examined in the course of a somewhat detailed study of air bacteriology now being carried on by the New York State Commission on Ventilation. The average 20° count of 64 samples was 59 microbes per cubic foot. Twenty-four samples showed less than 25, 18 between 26 and 50, 8 between 51 and 100 and 14 over 100. The maximum count was 395. At 37° in two days the average count was 48 microbes per cubic foot. Thirty-six samples were below 25, 9 between 26 and 50, 9 between 51 and 100 and 7 over 100. Acid forming streptococci were absent from 12 cubic feet of air examined for their presence.

The Usefulness of Dried Stained Smears of Milk as a Means of Determining the Sanitary Quality of Milk: Robert S. Breed and James D. Brew.

A number of tests of the method of making milk smears devised by Prescott and Breed[4] have been made at the Geneva Experiment Station with a view of determining the sanitary quality of milk. It has been found to be a very rapid and efficient method of determining the total germ content where milk contains 100,000 or more bacteria per c.c. The results secured probably represent the real conditions so far as total content is concerned better than those secured on agar or gelatin plates. By means of this test it is possible to separate milk as received at a milk station into two classes by a rapid examination of the prepared smears. The first grade of milk is that in which no bacteria are seen in 5 to 10 or more fields of the microscope. In all but eight of the sixty samples in which no bacteria were found the agar plate count was less than 100,000 per c.c. and seven of the eight which exceeded this figure were less than 200,000 per c.c. Such milk would sell in the New York City market as Grade A, selected pasteurized if properly pasteurized. Inasmuch as a large proportion of the milk received at the particular milk station where the tests were made was of this quality this test would have been used to great advantage because it would have enabled the dealer to raise this part of his milk from Grade B to the Grade A class at no expense to himself or to the farmers supplying the milk except the cost of making the tests, which is fortunately not great enough to be prohibitive.

The second class of milk would be that in which bacteria are readily found with the microscope. Such milk under present regulations would go on the market as Grade B milk if properly pasteurized. The great advantage of this test over plate methods of examinations or other bacterial methods that require an incubation period, is that results can be secured in a very few minutes and a large number of samples can be handled by a single person. Any person sufficiently skilled to handle a microscope can learn the technique and apply the method successfully. The chief weakness of the method at present is that it is so new and has been tried out so little in a practical way that no one knows as yet how the results secured should be interpreted. The bacterial counts obtained are much higher than those obtained from the ordinary plate counts and there is no constant relationship between such counts where single comparisons are made. When a long series of comparisons are made between plate counts and these microscopic counts, it is found that greater discrepancies occur when the total number of bacteria is low than when the total number of bacteria is high. A detailed report on this work will

4 *Journal of Infectious Diseases*, 7, p. 632, 1910.

be published in a technical bulletin of the New York Experiment Station.

Field Organization and Laboratory Technique, Canadian Section—International Joint Commission Pollution Investigation, 1913: F. A. DALLYN.

Period of investigation—April 10 to October 10, 1913.

Field laboratory located at nine (9) bases, from Fort Frances, Ont., to Kingston, Ont.

Equipment at each base comprised:

2 incubators — 18° C., — 22° C. and 37° C., designed to hold maximum number of samples.
2 sterilizers, one for glassware and the No. 3 Bramhall Deane Autoclave.
400–500 petri dishes with copper cases, 4 copper 25 c.c. pipette cases containing 30 pipettes each, 3 copper 1 c.c. pipette cases containing 60 pipettes each, 300–400 6-oz. glass stoppered sample collection bottles.
Apparatus for obtaining deep samples.
Several hundred Dumas bulbs, necessary table apparatus and media-making equipment.

Twelve thousand eight hundred (12,800) samples were collected and examined. The determination of the total bacteria count on nutrient agar (+ 10) at 18° -22° C. (48 hours), the count at 37° C. (24 hours), and the quantitative estimation of *B. coli* as indicated by fermentation in lactose bile at 37° C. (48 hours), not less than four (4) dilutions used for the latter—usually 1, 5, 25, 50 c.c. were tubed (1/1000, 1/100, 1/10) only when required. Sample collection points were located on straight lines by a time interval method (checked by different landmarks, buoys and lighthouses). Stoppers and necks of sample bottles protected from contamination by a rubber dam held by a band. The dam was dipped in mercuric chloride solution before being re-used.

Each field laboratory examined on an average of 52 samples per day. *Max. amount* 103 samples per day for 3 days in succession. Ten (10) to twenty (20) daily samples taken at each sample collection point. Special paragraphs on tabulation, accounting system, plating and tubing technique, handling of media, media reaction and washing of glassware.

The Virulence of the Resistant Minority: FRANK SCHOFIELD.

The work described has been done in an endeavor to obtain facts which would give a satisfactory basis for answering the following questions: Considering bacteria of the same species, have those which exhibit the greatest resistance to germicidal action a corresponding increase of pathogenic power over their fellows which succumb? Or, are the few which survive exposure for long periods to detrimental conditions practically innocuous?

In the experiments done swabs were inoculated from pure culture of *B. Diphtheria* and placed in the sunlight and others in the dark. At the same time definite quantities of special broth were inoculated, incubated for two days and varying amounts injected into guinea-pigs of known weight. Cultures were made from the inoculated swabs at different periods such as 30 days and number of colonies developing noted, for instance 100, then again at 35 days when number of colonies might be 5[?]. By careful manipulation the time when but two or three organisms capable of growing on the culture media were left could be estimated. Such colonies would represent the most resistant of the strain used. From such colonies broth was inoculated and incubated under similar conditions, as at the beginning of experiment. Guinea-pig inoculation was made and results compared with results recorded at commencement of experiment. A series of eleven experiments such as these were undertaken and the results warranted the following conclusion: That cultures made from the most resistant individuals of a strain usually exhibited pathogenic properties similar to the less resistant organisms of same strain, the virulence neither being increased nor decreased materially.

The Influence of the Hypochlorite Treatment of Water upon the Development of Algæ: CARRIE M. DERICK.

Professor Derick briefly reported some general observations incidentally made by a graduate student, Miss Clare Miller (Mrs. Wasteneys), in the course of a study of the Algal Flora of the Island of Montreal, in 1911 and 1912. Collections of algæ made in October and November, 1911, were maintained in sixty or more aquaria in the botanical laboratories of McGill University. In addition to series in various media, parallel cultures were grown in ordinary tap water. At that time, the city water was being regularly treated with hypochlorite of lime, less than one part to a million parts of water being used. The development of deleterious bacteria being thus prevented, the cultures of algæ in this water, which contained all the necessary mineral nutrients, were unusually vigorous and long-lived. At temperatures about 20° C., blue-green algæ, especially *Oscillatoria tenuis* Ag., *O. splendida* Grev. and *Rivularia hæmatites* Ag., flourished. *Anabæna*, on the contrary, usually died or passed into a resting condi-

tion within a few days. In March, however, it reappeared and grew well. Desmids, such as *Cosmarium*, *Closterium* and *Micrasterias*, as well as *Mougeotia*, *Ulothrix* and *Stigeolonium*, which were collected in the spore stage, germinated and grew readily at a temperature of 20° C. *Spirogyra*, *Vaucheria* and *Cladaphora* were most successfully grown at a temperature of 5° C. or less. The majority of the Chlorophyceæ collected grew vigorously in city water, provided that the temperature was between 5° C. and 20° C. *Vaucheria*, *Scenodesmus* and other Protococcaceæ flourished throughout the year. *Œdogonium* and *Chætophora* developed freely towards spring. Diatoms, such as *Navicula*, were plentiful at low temperatures. By periodically renewing the water to prevent the concentration of the mineral contents and by guarding against excessive exposure to strong light, many aquaria were kept in good condition during the following summer and supplied much material used for class-work throughout the winter of 1912–13. Towards spring, in 1913, *Scenodesmus* and a few other types crowded out less resistive groups, and the cultures were allowed to die during the summer of 1913.

Algæ similarly treated in the autumn of 1913 have not developed well. The summer was unfavorable to the majority and they were not in good condition when collected. *Spirogyra* and other Conjugatæ, several of the Protococcaceæ and *Œdogonium* began to grow after a few weeks. But in December, practically all of the aquaria contained species of *Bacillus*, *Spirillum* and *Vibrio*, as well as one or two water molds. Several factors probably contributed to this result. A less rigorous use of hypochlorite of lime in the treatment of the city water was suggested as a partial explanation by Dr. Adami during the discussion which followed the reading of the paper. It is obvious that when water-supplies are freed from bacteria by means of hypochlorite of lime, such a free development of algæ is permitted as to require treatment by copper sulphate or other measures to prevent pollution.

Toxic Products in Food and Their Detection: CHAS. H. HIGGINS.

Outline of necessity for the formulation of a method which could be used as a standard in routine examinations connected with the administration of the Meat and Canned Foods Act.

Three forms of poisoning in meat food products recorded by Edelmann. These are: (1) poisoning resulting from an infection by the *Bacillus enteritidis* (Gärtner); (2) poisoning resulting from the toxic products of the *Bacterium coli*, *proteus* species, etc., (3) poisoning resulting from the *Bacillus botulinus*. These food poisonings are the result of a direct bacterial infection or the poisoning from toxic products formed during their growth. Methods of detection are bacterial, such as Rosenau's, the *boiling test*, judgment depending upon the odor and the various feeding tests, principally with mice. None of these meet the requirements of routine examinations, as the individual element is an important factor and one that can not be standardized. The method employed is through the preparation of a solution of the material under consideration; in the case of commercial gelatines a ten per cent. solution, and following the method of Rosenau injecting this subcutaneously in amounts of 1 c.c. to 10 c.c., which contain from 0.1 to 1.0 of the original gelatine. For other meat food products the method is similar save that the food is leached with normal saline or distilled water, either proving equally satisfactory. In every case ten guinea-pigs are used, preferably of 250 grams weight, these having been shown to be most suitable for this purpose.

This method was used on upwards of two hundred samples. In one instance untoward effect occuring in sixteen persons, was directly traced to gelatine entering food product. In other cases untoward effect was found to be due to faulty methods of handling.

Proteid products have not interfered with the results and have not led to uncontrollable factors. Judgment depends upon the presence of illness or death among the inoculated animals. Period of observation, five days.

A. PARKER HITCHENS,
Secretary

(To be continued)

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and seventieth regular meeting of the society was held at Columbia University on Saturday, April 25. The attendance at the morning and afternoon sessions included forty-four members. Ex-president Bôcher occupied the chair, being relieved by Vice-president Eisenhart, Ex-president Fiske and Professor Tyler. The council announced the election of the following persons to membership in the society: Dr. T. H. Brown, Yale University; Dr. Josephine E. Burns, University of Illinois; Professor C. F. Gummer, Queen's University, Kingston, Ontario; Mr. G.

M. Hayes, College of the City of New York; Dr. W. L. Miser, University of Minnesota; Professor Maximilian Philip, College of the City of New York; Mr. S. A. Schwarz, College of the City of New York; Professor A. G. Smith, State University of Iowa; Mr. W. A. Wetzel, College of the City of New York. Ten applications for membership in the society were received.

Professor L. E. Dickson was reelected a member of the editorial committee of the *Transactions* for a term of three years. It was decided to hold the annual meeting this year in New York.

The society has recently published the Madison Colloquium Lectures, by Professors L. E. Dickson and W. F. Osgood, being volume 4 in the Colloquium Lecture Series.

The following papers were read at this meeting:

A. R. Schweitzer: "An extension of functional equations."

L. P. Eisenhart: "Transformations of conjugate systems with equal point invariants."

H. H. Mitchell: "The subgroups of the quaternary abelian linear group."

R. D. Beetle: "On the complete independence of Schimmack's postulates for the arithmetic mean."

H. S. Vandiver: "Extension of the criteria of Wieferich and Mirimanoff in connection with Fermat's last theorem."

E. G. Bill: "Note on the curvature of a regular curve in non-euclidean space."

S. A. Joffe: "Triangles whose sides are three consecutive integers and whose area is an integer."

G. D. Birkhoff: "The restricted problem of three bodies. Second paper."

A. B. Coble: "Cremona groups determined by point sets."

Anna J. Pell: "Non-homogeneous linear equations in infinitely many unknowns."

Louise D. Cummings: "On a method of comparison for triple systems."

C. L. E. Moore: "A geometry whose element of arc is a linear differential form."

C. L. E. Moore: "On the centers and radii of curvature of curves traced on a surface in an n-space."

J. E. Rowe: "Invariants of the rational plane quintic and of rational curves of odd order."

J. K. Lamond: "Some applications of a theorem of W. H. Young."

Maxime Bôcher: "On a small variation which renders a linear differential system incompatible."

R. C. Archibald: "Euclid's book on division of figures."

C. E. Wilder: "On the degree of approximation to discontinuous functions by trigonometric sums."

E. J. Miles: "Transversality and orthogonality of space extremals."

P. R. Rider: "Broken extremals in space."

R. L. Moore: "Linear order in terms of point and limit."

T. H. Gronwall: "Triply orthogonal systems containing one family of minimal surfaces."

The summer meeting of the society will be held at Brown University, on September 8-9.

F. N. Cole,
Secretary

THE PHILOSOPHICAL SOCIETY OF THE UNIVERSITY OF VIRGINIA

At the regular monthly meeting of the Scientific Section of the society on February 16 Dr. W. J. Humphreys, Professor of Meterological Physics, U. S. Weather Bureau, delivered an address entitled "Volcanic Dust and other Factors of Climatic Control."

On March 23 Professor Graham Edgar presented a joint paper by himself and Mr. S. H. Diggs entitled "The Influence of the Concentration of Potassium Iodide on the Rate of Diffusion of Iodine in Potassium Iodide Solution."

On April 20, 1914, Professor J. S. Grasty presented a paper on "The Shore Lines of the Ore Beds of the Clinton Formation in Alabama."

L. G. Hoxton,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

A paper read before the American Philosophical Society on April 3, by Ambrose E. Lehman, "Explorations in the Hudson Bay Region, with Reference to Unusual Topographic and Hydrographic Features and Mineral Deposits," announces the discovery of rich molybdenite ores, at a point immediately south of the new National Transcontinental Railway, in the northern section of the Province of Quebec, 440 miles northwest of Quebec, Indian Peninsula, Keewagama Lake.

Molybdenite crystals and flakes occur in persistent quartz veins traversing the granite and pegmatite rocks of the Laurentian formation.

Exploration and development of the deposits thus far exposes the ore near the surface, in such quantity as to warrant the belief in the magnitude of the find being greater than any heretofore discovered and developed of this rare metal.

SCIENCE

FRIDAY, MAY 29, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DAY OF THE EXPERT[1]

THE papers read before the American Association of Museums during the eight years of its life have covered a wide range of topics, reaching, one might imagine, the whole circle of museum interests. Yet there is one question, antecedent to all others, which has never been asked, and but once approached, in your presence. This is the question: Just what use are all these papers? We meet to develop and exchange our ideas; but when we separate, what power have we to put into effect what we have concluded and learned? We have the voice here. How much voice have we at home?

This question of official scope we share with every similar association; and with several it has recently become a burning question. Just a year ago there was formed an association of university professors for the determination and maintenance of professorial rights; and last winter the American Political Science Association and the Philosophical and Psychological Associations appointed committees to consider and report upon like matters.

A problem of problems like this offers appropriate matter for an initial presidential address; and its simultaneous agitation elsewhere suggests treating it in the broadest possible way—as a concern, not of one profession, but of all professions. Thus amplified, the topic becomes that of the present and future status of the specialist in the United States. Far as this theme stretches beyond the work of the permanent

[1] Presidential address, given at the ninth annual meeting of the American Association of Museums, held in Milwaukee, May 19–21, 1914.

public exhibitions we call museums, the inquiry into the day of the expert is one that vitally touches the whole official activity of every museum worker. The inquiry naturally divides itself into four:

What has been the position of the expert among us?

What change suggests itself?

What are the bearings of change?

What are the prospects of change?

We shall offer replies to these questions in succession: (1) by arguing that the prevailing attitude of institutions of the humanities in this country toward their expert employees is out of date; (2) by specifying a reform that would bring it up to date; (3) by meeting criticism of the new order; and (4) by noting its approach. We shall describe an outgrown condition, state and defend an adjustment, and report progress toward it. A glimpse of the past will lead to a glimpse of the future.

By expert will here be meant a person whose achievements demand special aptitudes long exercised; and by his day a time when these developed abilities are used to the best advantage of the community.

For the expert in this country, to-day, according to frequent remark, is not such a time; but there are signs that to-morrow will be.

Here and now, the work of the expert is largely carried on as a branch of corporate activity. Our men of science, pure and applied, our lawyers, doctors, educators, clergymen, social workers, artists and students of art, while they may practise their specialties alone, very commonly also serve some corporation, and in great numbers serve a corporation exclusively, as do most of us assembled here.

A corporation is a body of men empowered by the state to join in a certain purpose, and held responsible for its due fulfilment. At the end of his brief and hampered career as premier of England, Lord Rosebery is reported to have said: "Responsibility without power is hell." To be discharged successfully, duty must be coupled with corresponding authority. This is the foundation principle with which any study of the corporate sphere of the expert must begin.

A corporation engaging the aid of a staff is responsible at once for every detail of their action in its service, and for every detail of their outside life, in so far as this reacts upon their official activity; and hence possesses equivalent rights of control, subject only to law and custom.

Rights of total control presuppose in turn competence for total control. To ensure it, two methods of selecting the membership of a corporation are possible. In giving a certain purpose into the sole charge of certain persons, regard may be had either to the purpose chiefly, or to the persons chiefly; to their special competence, or to their general competence.

In the history of this country, the choice among men of the professions concerned was a colonial method; that among men of ability, however displayed, has been our national method.

The colonial method was an inheritance from the old world. Leonardo da Vinci is spoken of as the last European to take all knowledge for his province. With the development of the sciences and the arts after him, even men of commanding powers became specialists. Following the example of the mother country, the colonies placed their first colleges under the control of educational experts—in the main their clerics par excellence, or clergymen. An interpretation of the charter of Harvard College of 1636 given later by the colonial legislature, affirmed that the corporation was restricted to members of the teaching force; as the corporations of Oxford and Cambridge in

England still are. The charter of Yale College was issued in 1701 to ten clergymen, and provided that their successors should always be clergymen.

At the birth of our nation, the emphasis turned from purposes to persons, under the compelling force of two causes: the parity of our voting citizens, and the conditions of a new national life.

From the beginning of the new union one man was as good as another at the polls. Every vote cast was given the same weight. It followed that the recognition of the likenesses of men became dominant, and the recognition of their differences obscured. Leading men came to be thought of as like exponents of the sense and efficiency of the community. The acknowledgement of competence took the form of an acknowledgment of general competence. We of the United States have been nurtured in the belief that a man who has distinguished himself in any one direction will also distinguish himself in any other.

Our early national experience confirmed the belief at every turn. Pioneer conditions bring out the all-round man. The solid citizen in a new community is called on to be at once a farmer for sustenance, a manufacturer for clothing, a builder for shelter and a soldier for defence; often also a lawyer for justice, a doctor for the body, an educator for the mind or a teacher for the soul. The nascent civilization of the United States had its Leonardo da Vinci in Benjamin Franklin. Nor has our later progress yet thoroughly dislodged the ideal of the all-round American, fit for any task. The subjugation of a continent is in the main a business matter, and an able man may learn a business in all its branches. The practise of naming any capable person for any office has maintained itself among us because surpassing excellence has not for the most part been essential. We have fought successful wars with citizen soldiery and grown great in peace with practical men as intellectual guides. To Amiel our democracy announced an era of mediocrity; Schopenhauer called us a nation of plebeians; an Austrian royal visitor missed among us the sense of personality—the perception of that delicate but real differentiation that makes each man himself and no one else. This is the mark left on the society of the United States by our day of small things.

That day is now past; and it behooves us to examine the foundations of the emphasis which our methods of assigning responsibility impose upon persons instead of upon purposes, upon general repute instead of special fitness. When examined, our course proves an aberration from that of colonial times learned in Europe. We must go back upon history; but only to go on to a new social ideal which shall square at once with our political creed and our existing national conditions.

First, as to our political creed. The parity of voters obscures, but also implies the difference of men's capacity. In affirming that persons of a certain sex and reaching certain mental, moral and economical standards should be counted alike in the process of government, it presupposes others who do not possess these qualifications and are not to be counted at all. The conception of the equal distribution of capacity among men is negatived by the political device itself which fostered it.

It may be asked: What then becomes of the belief that men are created equal? If that renowned assertion does not mean that one man is as good as another, that all persons would show like capacity with like opportunity, what does it mean? Something totally different. Did it claim that every babe newborn might under favorable circumstances become what any other may, it

would seek to persuade us that males might become mothers. Instead of this and other absurdities but little less glaring, it proclaims the logical postulate that all real differences of human capacity are sensible facts of the present world. In Jefferson's glowing words, the inhabitants of this created frame bring none of their disparities with them from the invisible. There are no such things as divine rights, withdrawn from human scrutiny. The doctrine of equality affirms that only those persons who show themselves different should be treated differently. Its motto is the Roman challenge *"Aut tace, aut face"*—in modern American "Put up or shut up." True democracy is scientific method applied in politics. It accepts as inevitable in the political sphere also what Huxley called the great tragedy of science—"the slaughter of a beautiful theory by an ugly fact." The belief that a man who has shown exceptional powers in any one direction will also show them in any other is such a beautiful theory, exposed by our political creed to slaughter by ugly facts. Within narrow limits they confirm it. A capable farmer or efficient selectman will in all probability prove a good teacher of the rule of three, or a good postmaster. Beyond narrow limits they disprove it. Probably neither could teach Abelian functions well, or manage a wireless station. But whether verified or falsified, it is not the generalization itself, but the test of it, which is the sum and substance of the principle of equality. This is a doctrine of method, not a statement of results. It repeats in modern words the ancient injunction—"By their fruits ye shall know them." It is the merit system generalized. Admitting all verifiable disparities of human capacity, and excluding all mystic disparities, the equality of the Declaration is simple common sense. Denying them all indiscriminately, the equality of its interpretation is literally nonsense.

Second, as to our national conditions. They are no longer those of pioneer life. The task of leading the civilization of the United States has ceased to resemble a business. No man, however able, can learn it in all its branches. Growth, as is its wont, has developed heterogeneity from homogeneity. The arts we now practise have become as long as the lives we can devote to them. Our farmers, our manufacturers, our builders, our soldiers, our lawyers, our doctors, our educators, our religious leaders, are now different persons, each given wholly to his work. The era of the all-round man has at last gone by for us also, as centuries ago it went by for the old world. The excellence that comes alone from the long exercise of special aptitude is everywhere demanded, and the demand is everywhere being met. The era of mediocrity, the nation of plebeians, is on its way to bringing forth aristocracies of demonstrated ability, and the sense of personality—the recognition of that delicate but real differentiation that makes each man himself and no one else—will not long delay its advent.

The democracy of individuality, the democracy that accepts all proven differences and no others, is the new social ideal, squaring at once with the creed of our fathers and our own conditions. With our political creed, for the doctrine of equality, in denying all supersensible differences, stops short at the sensible world. Personality is its presupposition. With our national conditions, for the all-round man is bested in every line by the exceptional man in that line, and only the best has become good enough for us. The Jack-of-all-trades is master of none, and our progress calls for masters everywhere. Finally, the democracy of individuality makes for the union

in which there is strength. The new ideal is not that of a society of persons increasingly like each other, and hence increasingly sufficient each to himself, but of persons increasingly different each from the other, and hence increasingly necessary each to the other. While the Declaration proclaimed our independence of other peoples, it assumed our interdependence among ourselves. A citizenship of similars is like the sand, composed of particles each as complete as any and with no tendency to cohere; and a political house built upon it will fall. A citizenship of dissimilars is like the rock, composed of particles supplementing and cleaving to each other; and a political house built upon it will stand.

But we have not yet acquired the courage of our fundamental political conviction, nor yet thoroughly adjusted ourselves to our larger life. The administration of collective enterprises in the United States is at present in a state of unstable equilibrium. The question of the corporate sphere of the expert is not yet settled because not yet settled right.

While the actual fulfilment of corporate purposes has in general grown beyond the competence of any but those of special aptitude long exercised, our national habit persists of placing these purposes in charge of men of ability however displayed. Any conspicuous success, especially financial success, opens the way to a position of corporate authority. The necessary result is a permissive system of control. A corporation among us executes its trust by choosing paid assistants of the special ability required, and permitting them to carry out its purposes more or less in their own way. This situation of power perforce in abeyance is one of unstable administrative equilibrium. What is permitted can also be forbidden, and may at any time be forbidden by an authority alive to its responsibility and conscious of its power. In this event two rights to control come into conflict: the right based on capacity and the right based on law. The uncertainty of the situation is plain in the case of institutions of the humanities. Only an Orientalist can determine what antecedent study should be demanded for a course in the Vedas, only a technician whether quaternions should be used in teaching engineering, only an experimenter when a culture should be transferred from sun to shade, only a librarian what system of shelf numbering is applicable to fiction, only a surgeon how to conduct an operation in tracheotomy, only a religious leader to what spiritual exercise to invite a soul in need, only a curator how to install an ecological exhibit or make a collection of prints tell on the public, only an alienist how to control *melancholia agitans*, only a social worker how far the same methods of help are fitted to Syrians and Chinese. Yet others make up the boards on whose responsibility, by whose authority, and at whose option such decisions are taken. The permissive system settles the question of the corporate sphere of the expert but temporarily; leaving competence subject to impotence. It presents a problem, and one only to be solved by the union of the two potentially opposing rights. In the end, capacity must be given a legal standing. The skill demanded of the employee must be represented among the employers.

In contrast with the permissive system of control, that exercised according to this conclusion by a mixed board may be called the positive system. The terms refer respectively to the power of veto and the power of fiat. The positive system proposes that a corporation shall be constituted with a competence as all-embracing as its authority. Concretely, and considering charitable foundations only, it proposes that pro-

fessors in our colleges and technical schools shall be represented among the trustees of those institutions, librarians and heads of departments among those of libraries, scientific men among those of institutions of research, physicians among those of hospitals, clergymen among those of religious establishments, directors and curators among those of museums, social workers among those of foundations for popular betterment. In the most general terms it claims that any corporation should include members embodying in their own persons the special types of skill essential in carrying on its work. This claim is based on the conditions of permanent efficiency in collective enterprises. Its recognition is growing among us and will one day be general. That day will be the day of the expert.

Such a change in the make-up of corporations in this country may be said to round out an organization which practical sagacity has already partially developed in foundations of private origin and public aim among us. The men of general repute which it has been our custom to choose for positions of charitable trust have acquired by the logic of events their special necessary function in the fulfilment of these trusts. This function is that of winning support for the institutions they control. In our own country more than in any other, corporations not for profit are the fruit of private initiative. The first requisite for their establishment and maintenance is the selection of a board of trustees whose names, with those of their successors, will be an earnest of coming gifts because a guarantee of their safe and conscientious handling. Before we can do anything, we must have something to do with. But although ample and assured support is a condition necessary to the success of an institution, it is not a condition sufficient to success. A function equally necessary, and with support sufficient, is that of the accomplishment of purpose. This is the second and no less exacting half of the task; with us overshadowed by the first, because the accumulation of our wealth has outrun our provision of knowledge and skill to utilize it. The positive system of control repairs this omission, now out of date. It supplements our present provision of means by providing also for ends. It would impose the total charge of an institution upon a body fitted to bear both halves of it. Neither the men of social and financial standing who now compose the boards of our charitable institutions, nor the specialists now active in their aid, but now commonly excluded from those boards, are equal to the whole duty. Only men of affairs are competent to the business management of their trust. Only men in comparison withdrawn from the public eye in the long exercise of special aptitudes are competent to its professional conduct. The men of means and the men of ends must join forces in order to the best achievement of their common purpose.

The practical application of the principle of control by mixed boards presents various questions.

Is the demand that all the different forms of professional skill utilized by a corporation shall be represented therein an ideal realizable in the instance of large institutions? Theoretically no; practically yes. All the expert ability employed will in a measure be represented by each professional member; and by rotation in office among them, the recurrent grasp by the board of the affairs of the foundation may be extended to minutiæ in any degree.

Again, is it wise to place experts in charge of experts? The point may be debated, but is irrelevant. The positive sys-

tem does not propose to do so, but to give them a share in controlling others. The question—Who shall decide when doctors disagree?—finds its answer when another equal authority is present to add considerations beyond the scope of either. Such deciding voices are provided for in the mixed boards contemplated in the positive system. Its ideal is that every form of consideration which enters into the work in hand shall have its representative in the body which controls.

Again, should the experts employed by a charitable corporation be eligible thereto, or ought its professional membership to be chosen outside? Choice from the staff suggests a double doubt. Suppose a superior officer and his subordinate chosen; would not their equality on the board weaken the administrative control of the superior? No; for the equality is that of ultimate authority. The superior exercises his control as the delegate of the inferior as well as of himself and others. The inferior who disputed it would question his own right. There is no surer means of interesting any one in subordination than to give him power.

The doubt has another bearing. It also reflects the importance of the individual interests at stake in the case of employees. Will not their concern for their pay, as a rule, dominate their concern for their work?

The democracy of similarity says yes. The craving for money is the dominating motive in all men at all times. The democracy of individuality says no—basing its reply on a distinction. As social affairs are now arranged, some money is a perpetual necessity to us all, hardly less inexorable than the air we breathe. Else why should men and women still starve among us? But more money is an increasing luxury, the desire for which may be outweighed by many other interests. The *auri sacra fames* is an illegitimate child of the hunger for bread. In the case of the paid expert in a charitable corporation, some money is at most times assured, and motives are at all times present capable of tempering the desire for more. There are thus two reasons why his interest in his pay will not certainly dominate his interest in his work. His salary, while always moderate, is within limits safe; and the long exercise of his special aptitudes is at once fruit and source of motives apart from those of gain. The patience with which the specialist follows his task is the result of the fascinating germinal power of the ideas upon it of which his brain is the theater, and which his hand transfers to real life. They may become an efficient anti-toxin for the *cacoethes habendi*. Those who have had much to do with experts can echo the statement of Renan—"The reason why my judgments of human nature are a surprise to men of the world is that they have not seen what I have seen." To admit a rule by which experts when paid shall be excluded from charitable boards is to commit the absurdity of at once recognizing the exceptional man and treating him as if he were like all other men. Other grounds of bias—the desires for honor and power—unpaid members share with him. The receipt of pay as well will not disqualify those worthy of it.

Again, how are the permissive and the positive systems, respectively, related to the rights of free thought and free speech? These universal rights, so-called, are in essence duties of men in power. They should see to it that they do not so uphold the social order as to bar its advance. While all authority, therefore, is obligated to reduce to a minimum its repression of ideas and their utterance, no organization of control will absolutely prevent all danger of too high an interpretation of this minimum.

But a system by which seekers after truth in corporate service themselves share in the management tends to keep it within bounds. The positive system of corporate control thus obviates a danger to freedom inherent in the permissive system. It comes to the aid of free thought and free speech, entails a liberation of the spiritual forces within a nation.

The inclusion in charitable boards of men experienced in the actual accomplishment of their purposes is not new in this country either as a fact or an ideal. Their representation, never wholly lacking, is growing, and its extension is advocated with authority.

Frequently, if not commonly, a single chief executive officer, the head of the staff, is included in the board of trustees. The old ideal of the all-round man lingers in this provision, here swollen to impossible proportions. The admitted difficulty of finding satisfactory executive heads for institutions of the humanities is the sign of an unreasonable demand upon human capacity. No single executive, however active and talented, can embody in himself various types of modern professional knowledge and skill. The due representation of men of ends in any considerable corporation will always be a number greater than unity. A fair fraction of the board must be selected from their ranks. The demand upon the executive is thereby decreased to the manageable proportions of a business leadership, either with or without a special professional function.

Specialists have found a place already in a number of our scientific and artistic corporations. The charter of a noted scientific school, affiliated with a university, stipulates that of the corporation of nine, one third shall always be professors or ex-professors of the school. In another institute a larger proportion are persons in immediate control of the scientific work. No commanding need of appeal to the community for financial support existing in these cases, the men of ends have taken their natural place in the management along with men of means. Among museums of art more than one has chosen trustees from its own working staff and those of neighboring institutions.

In our chief universities, it has become the practise to allow the alumni a large representation in the board of trustees. Of the two bodies of persons concerned in the actual achievement of the teaching purpose—the teachers and the taught—this practise accords to one—the taught—its share in ultimate management. The step suggests, and may be believed to announce, a second, by which the other body—the teachers—will gain a similar representation. The class of alumni trustees has for its logical complement a class of faculty trustees; a class more indispensable to vital university success than their predecessors, in that they represent not the subjects but the source of university discipline.

The step has found prominent advocates. In the *Atlantic Monthly* for September, 1905, President Pritchett asks "Shall the university become a business corporation?" He suggests that the business of graduating men has little to do with the art of educating them, and concludes

> In the settlement of the larger questions of administration . . . may not some council composed of trustees and faculty jointly share the responsibility to advantage? . . . To-day we need, in my judgment, to concern ourselves in the university with the spiritual side of administration.

In articles entitled "University Control" published in SCIENCE in 1906 and 1912, Professor Cattell proposes that professors should take their place with alumni and interested members of the community in the corporation of a university, and re-

ports favoring opinions from a large majority of those holding the most important scientific chairs in the country. In his report for 1911–12 as president of Cornell University, Dr. Schurman writes:

The only ultimately satisfactory solution of the problem of the government of our universities is the concession to the professorate of representation on the board of trustees or regents.

Such agreement in a recommendation is a prophecy of its acceptance.

When the day of the expert arrives, every corporation employing specialists will have its class of professional members, whether in a majority or a minority, whether chosen within or outside the staff, whether for limited periods or without term. Historical causes have both denied and begun to restore to expert ability in this country a place in the corporations to whose work it is necessary. The system of positive control by mixed boards is a final settlement of the question of the corporate sphere of the expert because the right settlement, granting to competence its share in the management of competence. The day of the expert brightens on the horizon. Let us welcome its advancing beams. Either we ourselves, or our early successors, will be called to labor in its full sunshine.

BENJAMIN IVES GILMAN

April 15, 1914

A TRIBUTE TO DR. HENRY P. WALCOTT

THE following letter was presented to Dr. Henry P. Walcott on the occasion of his retirement from the Massachusetts State Board of Health:

TO HENRY P. WALCOTT, M.D., LL.D., CHAIRMAN, MASSACHUSETTS STATE BOARD OF HEALTH; FROM TWENTY-TWO HUNDRED MEMBERS OF THE MEDICAL PROFESSION OF THE STATE,—GREETING.

Sir: On the 19th day of May, 1914, your term as a member of the State Board of Health ends, and we understand you are not a candidate for reappointment.

Such an occasion can not be allowed to pass unnoticed, at least by those citizens who, as a class, should be most competent to gauge the value of such services to the state as yours have been.

The best appraisal of those services is the mention of some of them, with a brief statement of your relations to the board.

Your connection with the board began in 1880, 33 years ago, when, after ten years of independent existence, it had been merged with the conjoined Board of Lunacy and Charity, and you were unanimously elected its health officer. At this time, you served on a commission for the sanitary improvement of the Blackstone River, a precursor of your subsequent labors on similar problems.

In 1886, by an act of the legislature, the Board of Health once more entered upon an independent existence. You were appointed a member for a seven years' term by Governor Robinson, a Republican, with the advice and consent of the senate, and became the chairman. You have since been reappointed three times for terms of seven years: once by Governor Russell, a Democrat, in 1893; once by Governor Crane, Republican, in 1900; and once by Governor Guild, Republican, in 1907. Since 1886, you have always continued as chairman of the board.

Early in 1894, you began to consider the advisability of establishing a laboratory for the free production and distribution of diphtheria antitoxin; and such curative serum was actually distributed early in 1895, being the first so distributed in any state. This was made possible through the coöperation of Harvard University, secured by your influence, at the Bussey Institution, and was carried on for nine years—during this time as well as later under the personal direction of Dr. Theobald Smith—until 1903, when the legislature enacted a law authorizing the State Board of Health to produce and distribute antitoxin and vaccine virus. Again through your influence, a laboratory was built on the grounds of the Bussey Institution where the preparation of antitoxin and animal vaccine was carried on together.

Within the last four years, you have served as chairman of two state commissions appointed to consider various important tuberculosis problems: one in 1910, and one in 1912. Reports were made to the legislature and printed as public documents.

It is impossible to separate your work in connection with the Board of Health from that in connection with the North and South Metropolitan Sewerage Systems, the Charles River Valley System, the Charles River estuary improvement, the

Metropolitan Water Supply, and numerous other similar problems of perhaps secondary importance, such as the improvement of the Neponset River Valley, of the Concord and Sudbury rivers, of the sanitary conditions as respects water supply, sewerage, and sewerage disposal of many cities and towns which have been devised by the committee on water supply and sewerage of the Board of Health, of which Mr. Hiram F. Mills is chairman, and carried out in connection with its recommendations under your chairmanship of the board.

Since the reestablishment of the State Board of Health in 1886, under your chairmanship, it has been the custom of the legislature to refer all important sanitary questions to that board for investigation and advice, instead of creating special commissions, as obtains in many states. This custom, under your wise administration, has doubtless saved much money to the state and, at the same time, secured sanitary improvements recognized in all civilized countries as the best of their class.

The investigations and recommendations of the board have commended themselves to the legislature and in general have been carried out ultimately as presented.

From 1886 to the present time, you have been constantly and steadfastly facing these great and grave problems. Since 1895 when the State Board of Health made its report to the legislature, presenting a plan for the water supply of the city of Boston and the surrounding cities and towns, have been added to your responsibilities those of a commissionership on the Metropolitan Water Board. You have borne the responsibilities both of recommendation and of execution. . . .

You have met the responsibilities then assumed with such wisdom, discretion and rare modesty, as to make the task of your successor who would uphold the standards bequeathed to him a difficult one indeed.

THE EIGHTH REPORT OF THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

The eighth annual report of the president of the Carnegie Foundation for the Advancement of Teaching shows a total endowment of $15,325,000, and an expenditure for the year ending September 30, 1913, of $658,431. Of this $519,440 were distributed in retiring allowances to professors, and $80,949 in pensions to their widows, a total of $600,390. Thirty-three allowances were granted during the year, making the total in force 403, the average annual payment to an individual being $1,703. The total distribution from the beginning has been $2,936,927. The educational work of the foundation was separately endowed in January, 1913, by a gift of $1,250,000 from Mr. Carnegie through the Carnegie Corporation of New York. This body, which is endowed with one hundred and twenty-five million dollars for "the advancement and diffusion of knowledge and understanding," has five ex-officio trustees, of whom one must always be the president of the Carnegie Foundation for the Advancement of Teaching.

In connection with the foundation's work as a center of information concerning pensions, the president discusses pension systems that are maintained by half a dozen colleges, the development of new systems at Brown University, the Rockefeller Institute, and the American Museum of Natural History, the new federated pension system of the English universities, and the proposed system for the clergy of the Episcopal Church. Among pensions for public school teachers the report discusses the misfortunes of the New York City system, and commends the plans of the new state system in Massachusetts.

Much of the report is devoted to the development of the educational work of the foundation into a separate division of educational enquiry. Its recent work includes a study of education in Vermont at the request of the Vermont Educational Commission, of legal education at the request of a committee of the American Bar Association, and of engineering education at the request of a joint committee representing the national engineering societies.

The study of education in Vermont, already distributed, represents the first survey that has been made of a state's educational activities as a whole. The study of legal education has been begun by a first-hand enquiry into the bar examinations of every state, a special study of legal teaching by Professor Josef Redlich, who came from Vienna for the purpose, and by a personal examination of each of the 160 law schools in the country. Plans for

the study of engineering education are now being completed. The earlier educational work of the foundation is continued in the report by commendation of the present tendency of college entrance requirements toward both elevation and flexibility. The need for further improvement is shown by the fact that only 55 per cent. of the students now in our colleges are high school graduates. The decrease in the number of medical schools in the country from 162 in 1910 to 115 in 1913, and the rapid improvement of the better schools are commented upon with appreciation. A general study of the problems of the state regulation of higher education is illustrated by a detailed account of the recent crisis in educational affairs in Iowa.

The report further presents a study of the financial status of college teachers as compared with the situation presented in a similar study published five years ago. The ordinary salary of a full professor in the institutions associated with the foundation is now $3,000. During the last five years the salaries of instructors have risen by about $80; those of junior professors show a gain of from $120 to $225; those of full professors show an increase from $125 to $350.

The report concludes with a frank criticism of contemporary college catalogues. It is accompanied by the annual report of the treasurer. Copies may be had by addressing the Foundation at 576 Fifth Avenue, New York City.

THE PRELIMINARY ANNOUNCEMENT OF THE SAN FRANCISCO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science has decided to hold a general meeting of the association in San Francisco and vicinity on the occasion of the Panama-Pacific International Exposition, in 1915, and has appointed a Pacific Coast Committee of thirty-two members to make the necessary arrangements. This Committee has recommended, and the American Association has approved, that the sessions of the meeting shall begin on Monday, August 2, and terminate on Saturday, August 7. It has been decided that:

(1) The general sessions of the meeting shall be held in San Francisco.

(2) The general evening lectures shall be delivered in San Francisco.

(3) The sessions for the presentation of addresses and papers in the separate divisions of science shall be held chiefly at the University of California, Berkeley.

(4) Sessions for the presentation of addresses and papers in the separate divisions of science shall be held on one day at Stanford University.

Subcommittees of the Pacific Coast Committee will in due time supply information to the members of the American Association and to the members of such other scientific societies as desire it: on transportation, by railways and by steamers, including the Panama Canal route; on living accommodations in San Francisco and vicinity, and at other Pacific Coast points; on excursions; on the leading features of the Panama-Pacific International Exposition, and on other subjects of interest.

Holding in mind that the San Francisco events of 1915 are in commemoration of the union of the Atlantic and the Pacific, through the medium of the finished Panama Canal, and that the Pacific region is hereafter to be in closer relation with the states and nations lying east of the Cordilleras of North and South America, and with the nations of Europe, the Pacific Committee on Scientific Program has adopted the following resolution:

> In view of the fact that the occurrence of scientific meetings in San Francisco in 1915 is in a manner a part of the celebration commemorating the opening of the Pacific to the peoples bordering the Atlantic it seems fitting that the program of meetings held in connection with this celebration should relate, as far as possible, to problems of world interest which pertain especially to the Pacific area.

The committee desires to add, by way of comment, that this resolution is not intended to discourage the presentation of worthy

papers on any subject whatsoever, but is merely to lay emphasis upon the desirability of papers on subjects concerning the Pacific region.

There will be four general sessions for the delivery of addresses by eminent men on subjects of wide interest. There will be many simultaneous or alternating meetings for the presentation of addresses and papers in the principal division of scientific knowledge. It is proposed that certain half days or whole days of the week be left free from scientific programs in the respective divisions in order that members and others in attendance may visit the exposition and other points of special interest in the vicinity.

The Pacific Coast Committee hopes that the 1915 meeting of the American Association, at a point so far removed from the usual meeting places of the general and special scientific societies of America and from the homes of their members, may be remarkable for the number of members of these societies in attendance and for the wide interest and high standard of the addresses and papers presented.

Please address correspondence to Albert L. Barrows, University of California Library, Berkeley, California.

SCIENTIFIC NOTES AND NEWS

A committee has been formed in France, under the patronage of M. Poincaré, president of the Republic, for the erection of a monument in honor of J. H. Fabre, the famous entomologist. The idea is, not only to erect a monument at Serignan, but to preserve and to convert into a museum the estate of Harmas, the dwelling of the great naturalist. Subscriptions are asked from naturalists all over the world, and may be sent to the president of the committee, M. Henri de la Paillonne, mayor of Serignan (Vaucluse), France.

The medical faculty of Turin has decided to erect a memorial to the distinguished physiologist, Angelo Mosso, in the institute in which he taught for many years. The memorial will be unveiled on November 14, 1914, the fourth anniversary of Mosso's death. Contributions should be sent to Professor Alberto Aggazzotti, Corso Raffaello, Torino.

Rear Admiral Robert E. Peary, U. S. N., retired, has received the gold medal conferred upon him by the French Geographical Society on April 24.

Dr. Beverly T. Galloway, newly appointed director of the New York State College of Agriculture, Cornell University, has formally resigned his office of assistant secretary of the U. S. Department of Agriculture.

In addition to the Elliott Cresson medals presented by the Franklin Institute, Philadelphia, to Dr. Smith and Mr. Wright, noted in the last issue of Science, medals were awarded and forwarded through the department of state to Professor Linde and Professor Eder. The grounds of the awards are stated by the committee as follows:

Karl Paul Gottfried Linde, Ph.D., in recognition of his scientific investigations of the processes of refrigeration and the liquefaction of gases and of his inventions of machinery for applying these processes in the manufacture of ice and for the purposes of cold storage.

Edgar Fahs Smith, Ph.D., Sc.D., LL.D., in recognition of his leading work in the field of electrochemistry, of his many contributions to the literature of chemical science, and of his great service in university education.

Joseph Maria Eder, Ph.D., in recognition of his important original researches in the science of photo-chemistry and of his many valuable contributions to the literature of that science and of the graphic arts.

Orville Wright, B.S., LL.D., in recognition of the epoch-making work accomplished by him, at first together with his brother Wilbur and latterly alone, in establishing on a practical basis the science and art of aviation.

Lewis E. Moore, professor of civil engineering at the Massachusetts Institute of Technology, has been appointed engineer of bridges and signals of the Massachusetts Public Service Commission, and resigned from the faculty of the institute.

Dr. G. M. Guiteras, of the Public Health Service, has been called to Tampico, Mexico, with the consent of the constitutionalist forces,

now in control of that place to "clean up" the city.

Prevost Hubbard, in charge division of roads and pavements, The Institute of Industrial Research, Washington, and Arthur H. Blanchard, professor of highway engineering at Columbia University, have been elected by the council of the International Association for Testing Materials the American members of a commission on "Standardization of Methods of Testing and Nomenclature of Road and Paving Materials."

Selskar M. Gunn, professor of biology in the department of sanitary biology and public health at the Massachusetts Institute of Technology, has been made managing editor of the *American Journal of Public Health* succeeding Dr. Livingston Farrand, formerly professor of anthropology at Columbia University, now president of the University of Colorado.

Professor David Eugene Smith will represent Columbia University and the Bureau of Education at Washington at the Bacon Septenary celebration at Oxford on June 10, and at the Tercentenary Napier celebration at Edinburgh on July 22. He will spend the academic year 1914–1915 in travel abroad.

Dr. J. P. Iddings, of the U. S. Geological Survey, will lecture at the University of London from June 4 to 9 on "Problems of Petrology." Mr. Iddings is on his way to the Netherlands, Indies and the islands of the South Pacific to study igneous rocks, traveling under the auspices of the Smithsonian Institution of Washington.

President R. C. Maclaurin, of the Massachusetts Institute of Technology, is making a visit to the Pacific coast.

Messrs. Frederick G. Clapp and Myron L. Fuller, of the Associated Geological Engineers, Pittsburgh, are engaged in the examination of the northern parts of Chili and Shensi provinces in China for petroleum for the Standard Oil Company.

Dr. Elwood S. Moore, professor of geology and mineralogy at the Pennsylvania State College, has been granted a year's leave of absence for 1914–15, and plans to spend it traveling abroad. He will sail from San Francisco on June 23, for Australia, in order to attend the annual meeting of the British Association for the Advancement of Science. After six months spent in Hawaii, New Zealand, and the East Indies he will study the balance of the time, until the fall of 1915, at the University of Berlin with Professor Krusch, of the department of economic geology.

The annual stated meeting of the American Medico-Psychological Association is being held in Baltimore this week. A symposium on "Paresis" was announced for May 26. On the following day the annual address was delivered by Dr. Lewellys F. Barker on "The Relation of Internal Medicine to Psychiatry," and on the fourth day there was a symposium on "Eugenics."

Mr. W. F. Hillebrand, chief chemist of the U. S. Bureau of Standards, lectured recently before the Cornell section of the American Chemical Society on "Chemistry at the Bureau of Standards."

The Page-May memorial lectures of University College, London, for the current session will be delivered by Dr. Keith Lucas, whose subject will be "The Conduction of the Nervous Impulse." The course is given on Fridays, beginning on May 15.

Professor V. Karapetoff, of the department of electrical engineering, Cornell University, has completed an extended lecturing tour. His itinerary and topics were as follows: May 9, Springfield, Mass., an address before the Eastern Association of Physics Teachers on the subject of "Some Calculations in the Magnetic Circuit." May 11. Cleveland, Ohio, an address before the engineering students of the Case School of Applied Science on "The Production of a Revolving Magnetic Field." On the same day, a lecture before the Case School chapter of the Society of Sigma Xi on "The Dielectric Circuit." On Tuesday, May 12, an address before the engineering students of the Carnegie Institute of Technology,

Pittsburgh, on "Some Transient Electrical Phenomena," and on the evening of the same day, a paper before the Pittsburgh section of the American Institute of Electrical Engineers, a paper on "The Preparation and Qualifications of a Teacher in Engineering." On May 13, he addressed the students of the University of Pittsburgh on the "Electrification of Steam Railroads."

At the University of Glasgow on commemoration day, June 23, an oration on Lord Lister will be delivered by Sir Hector C. Cameron.

Professor Rudolf Tombo, Jr., of the department of Germanic languages, Columbia University, known also to readers of this journal for his articles on "University Registration Statistics," died on May 22.

We regret also to record the death of Mr. Herman Frasch, the industrial chemist, at one time chief chemist of the Standard Oil Company.

UNIVERSITY AND EDUCATIONAL NEWS

Lafayette College is a beneficiary in the will of Mr. William Runkle to the amount of $100,000.

The South Wales and Monmouthshire University College at Cardiff has received from an anonymous donor funds for the erection of a school of preventive medicine. The money value of this gift, together with that of Sir William James Thomas to erect a school for other branches of medicine in connection with the college, is estimated at £180,000.

The cornerstone of the Julius Rosenwald Hall at the University of Chicago will be laid on the morning of Convocation Day, June 9. The address will be given by Professor T. C. Chamberlin, head of the department of geology, who has been connected with the university since its founding.

The new building of the department of forestry of the New York State College of Agriculture was formally opened on May 15. Among those who made addresses were Professor James W. Toumey, director of the Yale Forest School; Dr. Henry S. Drinker, president of Lehigh University, Mr. Gifford Pinchot and Dr. L. H. Bailey.

The fiftieth anniversary of the founding of the School of Mines at Columbia University is being celebrated this week. On Thursday night there is a reception in the gymnasium. On Friday morning there well be a convocation at which honorary degrees will be conferred upon a number of eminent graduates of the School of Mines, and there will be addresses by Professor H. S. Munroe, Mr. T. W. Rickard and Mr. Hennen Jennings. In the afternoon the first lecture on the Chandler Foundation will be given by Dr. Leo H. Baekeland. The celebration will close with a dinner at the Waldorf-Astoria in the evening, at which Professor J. F. Kemp will preside.

The foundation stone of the new School of Tropical Medicine at Calcutta, for the site and laboratory of which the government of India has appropriated $195,000, was laid recently by the governor of Bengal. The *Journal* of the American Medical Association states that the institute will accept students from all over the world, and it is hoped that students of medical research institutions of the United States may be sent to the school for study. Communications regarding the school should be addressed to Lieut.-Col. Leonard Rogers, I. M. S., Medical School, Calcutta.

A new department, that of hygiene and bacteriology, has been created at the University of Chicago by the board of trustees. The chairman of the department is Edwin Oakes Jordan, professor of bacteriology, and associated with him in the work of the department are Assistant Professor Norman MacLeod Harris and Dr. Paul Gustav Heinemann. During the present quarter also Associate Professor William Buchanan Wherry, of the University of Cincinnati college of medicine, is giving courses in advanced bacteriology and parasitology. The work in bacteriology was formerly included in the department of pathology and bacteriology, which now becomes the department of pathology, with Professor Ludvig Hektoen as head.

VARIOUS sub-departments of geology at Cornell University have been consolidated under one head and the committee of professors which has hitherto administered the affairs of the department has been dissolved. Professor Heinrich Ries has been appointed head of the department.

MONEY is being collected to endow a professorship of railroading in the Graduate School of Business and Administration of Harvard University, to be named in honor of Mr. James J. Hill.

DEGREES will be conferred at commencement upon 101 University of Illinois matriculants of the years 1868–92, who completed 36 term credits and did not receive degrees. The belated degrees will be conferred as of the classes to which they belonged. These were not granted at the usual time because the students did not follow courses exactly prescribed.

CHARLES SCHUCHERT, professor of paleontology, has been elected acting dean of the graduate school of Yale University for next year in the absence abroad of Dean Oertel.

DR. FREDERICK A. SANDERS, professor of physics of Syracuse University, has been appointed head of the physics department of Vassar College.

DR. C. C. ADAMS, of the zoology department of the University of Illinois, has accepted the position of assistant professor of forest zoology in the New York State College of Forestry at Syracuse University.

HERBERT FISHER MOORE, assistant professor of theoretical and applied mechanics in the engineering experiment station of the University of Illinois, has been promoted to be professor of engineering materials.

MR. E. R. BURDON has been appointed university lecturer in forestry at the University of Cambridge.

DISCUSSION AND CORRESPONDENCE

MODESTY OVERWORKED

TO THE EDITOR OF SCIENCE: I am very loath to be drawn into the controversy on nomenclature, but in a recent number of SCIENCE (April 24) Professor Verrill has seen fit to hold me up to obloquy for having wantonly violated two rules, one of which is of his own selection. I do not intend to discuss the advisability of this rule further than to enquire who is to be the arbiter of what is "obviously obscene"? Professor Verrill evidently regards *Urticina felina* as an appellation falling under this category, while others, equally modest, might reject *Metridium*, which he accepts with equanimity. Even granting that certain Linnean names in their original form might bring a blush to the cheek of some *casta Minerva*, are they therefore, in their modern associations, to be rejected on that ground alone? Surely such a principle, consistently applied, would deprive the world of many of its greatest possessions in science, literature and art! *Honi soit qui mal y pense!*

Nor do I intend to notice the personalities contained in Professor Verrill's letter, but, when he disputes the correctness of my conclusions as to the validity of the names *Metridium senile* and *Urticina felina* he is entering upon a criticism to which one may reply. His contention that *Priapus senilis* and *P. felinus* are unidentifiable from Linnæus's descriptions I have fully recognized, but I also showed that Linnæus himself, in the twelfth edition of the "Systema," furnished the basis for their correct identification, by giving as references for them the recognizable figures in Baster's "Opuscula subseciva," a work that Professor Verrill carefully refrains from mentioning. It is quite unnecessary to repeat here the facts and arguments in support of this view, as they are fully set forth in my paper, whose main object, so far as these two species were concerned, was to show that the confusion that has arisen in the synonymy of their Linnean names was quite unnecessary and that these names are valid according to the ordinary rules of priority. Professor Verrill thinks otherwise and prefers the specific terms *dianthus* and *crassicornis;* but why does he reject Pennant's *pentapetala*, which apparently antedates *dianthus?* Surely it, too, can

not be regarded as "obviously obscene" or rather let us say, immodest. My position, in brief, is that we have in Linnæus's reference to Baster's figure very clear evidence of what he intended the term *felinus* to imply, and, this being so, the application of his term *senilis* also becomes clear. I prefer Linnæus's identifications of his own species to any speculations as to other possibilities.

I am quite prepared to assume responsibility for having advocated the revival of the Linnean specific names for the two species in question, but Professor Verrill asserts that I also advocate the adoption of *Priapus equinus* for the form that he prefers to term *Actinia mesembryanthemum* (properly *mesembrianthemum*). I do not recall ever having advocated the use of the original Linnean name for this species, and, indeed, in the paper which has become the object for Professor Verrill's fulminations, it is only once mentioned and then as *Actinia* (*Priapus*) *equina*. I gave the name that form expressly to indicate that while recognizing the priority of *Priapus* according to the International Rules, I hoped that the long-established name of *Actinia* would not be dropped from our nomenclature. Apparently my mode of expressing this idea has been somewhat too subtle. It would, indeed, be unfortunate if *Actinia*, with all its associations, should be obliterated and it would also be unfortunate if the familiar *A. equina* should disappear. For Professor Verrill's statement that "the leading European authorities, familiar with the actinians of the same region, have never been able to agree as to his (*i. e.*, Linnæus's) species" is quite erroneous so far as this species is concerned, and equally untrue is the statement that "most writers, before McMurrich, have wisely rejected the names," mainly on the ground of their immodesty. I have taken the trouble to look up the references to the species now under consideration during the twenty-five years that preceded the publication of my paper and find that in *thirty-eight* it is quoted as *A. equina* and only in *four* as *A. mesembryanthemum*, although in several the latter name is given as a synonym for *equina*. Apparently there are quite a number of zoologists unburdened by such an exquisite sense of modesty as would compel them to reject this Linnean name, and the most convincing reason for the non-use of *senilis* and *felinus* has not been that stated by Professor Verrill, but, as a review of the literature will clearly show, the confusion in their application which early arose and to which I have referred in my paper.

J. Playfair McMurrich

THE FANNY EMDEN PRIZE OF THE PARIS ACADEMY

To the Editor of Science: It may be of interest to you to record the fact that the Academy of Sciences of the French Institute has published a statement in regard to the award of the Fanny Emden prize for the year 1913. This prize is of the value of 3,000 francs and is the result of a bequest made by Mlle. Juliette de Reinach of 50,000 francs, the interest of which is available every two years. The prize is to be awarded for the best work "in the field of hypnotism, suggestion or in general, of physiological action which may be exercised at a distance upon a living organism." The fund was made available in 1911. Thirteen candidates presented researches, but no prize was awarded. In 1913 the prize was divided, 2,000 francs to M. Emile Boirac and 1,000 francs to M. J. Ochorowicz.

The peculiar wording of the award lies in the fact that the Academy makes these awards as *encouragement* for meritorious work, but sets forth that neither of the essays submitted goes very far towards proving its thesis. Indeed, the report rather decidedly indicates that they contribute rather little towards the establishment of any conclusion. The report cites one or two experiments of M. Boirac which are certainly questionable, and require extraordinary confirmation before they can be regarded as evidential in the sense presented.

Nothing is indicated in the report to show that a research proving the absence of any such action "at a distance," or its extreme improbability, would not be considered; but the very wording of the original bequest seems

to suggest a leaning in favor of a positive conclusion. It is certainly to be regretted that a problem of this nature should receive even so partial endorsement as is implied by the French Academy of Science. Since the conditions of the prize do not require specific investigations, but make it available for an argument indicating the position of psychology on such an hypothesis, I trust that for 1915 some candidate will present a statement that will more adequately express the views of a considerable proportion of modern psychologists upon this subject. Psychology receives so slight a recognition in scientific competitions that it seems unfortunate that its interests should be prejudiced by a recognition of a subject somewhat tangential to its main problems, and yet one upon which it has been forced to express itself in view of the widespread public concern.

JOSEPH JASTROW

SCIENTIFIC BOOKS

Flies in Relation to Disease: Non-bloodsucking Flies. By G. S. GRAHAM-SMITH, M.D. Cambridge, University Press, 1913.

A first reading of Dr. Graham-Smith's admirable book is apt in a way to somewhat dampen the enthusiasm of the ardent fly crusader. This is especially apt to be the case with one who, like the present writer, has recently been told by Stiles, after his experiences in the Carolinas, that the half has not yet been told of the danger of the house-fly, and who only the other day heard Levy of Richmond, in an address before the State Health Association, emphatically state that even the most exaggerated newspaper statements of the dangers have underestimated them. Perhaps if Dr. Graham-Smith lived in the Carolinas or in Virginia he might share to a certain degree the views of Stiles and Levy, but, living in England, and being a most careful, conscientious, and thoroughly scientific laboratory worker, he has in this book held himself down to absolutely demonstrated statements and has viewed the problem almost strictly from the medical side. He has thus produced a work which will be highly pleasing to conservative people who have diagnosed current newspaper statements about the house-fly as yellow journalism.

A second and more careful reading of the book, however, will show that there is an abundance of demonstrated facts upon which to base mose vigorous anti-fly crusades. He states that it is certain that the house-fly is a potential disease carrier and a constant frequenter and disseminator of filth, "but," he says, "much remains to be done before Howard's name, 'the typhoid fly,' or Hewitt's generalization can be completely justified." Hewitt's generalization, by the way, is "It has been proved that the house-fly plays an important part in the dissemination of certain of our most prevalent infectious diseases when the necessary conditions are present." Both Hewitt and myself (quoting from Graham-Smith) "approaching the subject from the entomological standpoint, have based their conclusions in regard to disease mainly on evidence of an epidemiological character and have apparently accepted the bacteriological evidence almost without criticism. From the bacteriological point of view, however, while the evidence relating to the carriage of pathogenic bacilli by experimentally infected flies is fairly conclusive, that relating to the presence of these microorganisms in 'wild flies' is far from complete."

The book is a very thorough and a very cautious one, and covers a consideration of the species of non-bloodsucking flies found in houses, the life history of the house fly, its internal and external anatomy in much detail, its habits, the ways in which it carries and distributes bacteria, the bacteriology of city flies, the fate of organisms eaten by larvæ, and a lengthy consideration of typhoid fever, summer diarrhea, anthrax, other bacterial diseases, the carriage of the eggs of parasitic worms, myiasis, the diseases and parasites and other enemies of flies, and questions of control. It is an admirable compendium, containing many facts not hitherto presented, and bringing together the latest information in a way in which it can be easily and intelligently consulted.

On account of the conservatism of the author, great interest attaches to such statements as he makes concerning actual danger from flies. He shows that infected flies not only carry bacteria on their bodies and limbs, thereby contaminating substances over which they walk, but distribute bacteria which they have ingested, by means of vomit and fecal deposits. He shows that, while non-spore-bearing bacteria survive at the most only twenty-four hours on the limbs, flies nevertheless infect substances over which they walk with such organisms for several days by means of a fluid which they regurgitate from their crops. He also shows that the majority of the non-spore-bearing bacilli pass through the intestine and are in living condition in the fecal deposits. He states that flies feeding upon tubercular sputum suffer from diarrhea, a fact which may be of some importance in relation to their potentiality for spreading infection. He states that city flies carry in and on their bodies very large numbers of bacteria, many of which are fecal types and that these are more numerous in flies caught in congested or dirty areas. Pathogenic bacteria or allied types have been isolated from wild city flies. "Flies bred from larvæ living in material infected with anthrax spores are capable of communicating the disease for some days after they emerge."

He admits that the evidence is very strong that flies are the dominating factor in the dissemination of typhoid fever in military and other camps and in stations in the tropics, and that there is some evidence that they are factors in causing the autumnal increase in typhoid in England, but agrees with Chapin that it is unlikely that they play an important part in well-sewered towns. The evidence in epidemic diarrhea of children he thinks is not altogether conclusive, largely I imagine because, although the disease is admittedly infectious, the causative organism has not been identified with certainty. He considers that the annual mortality due to this disease is so great that "a serious attempt to conclusively ascertain the part played by flies in its dissemination, by exterminating them in some suitable areas, usually exhibiting a high mortality, though expensive, would be justified." It is interesting to note that this is just what was done last summer in New York City by Dr. Donald B. Armstrong, of the Bureau of Public Health and Hygiene of the New York Association for Improving the Condition of the Poor, with results that are convincing, and Levy of Richmond, in an address as yet unpublished, states that he has reduced the mortality from infantile diarrhea in Richmond more than fifty per cent. by anti-fly work and great care to protect the diapers of sick children from flies. Armstrong's experiment, by the way, was accompanied by a rigid control.

With regard to cholera, he states that the evidence concerning its spread by flies is somewhat old, but is so remarkable that careful investigation is highly desirable.

Admitting that flies are greatly attracted to tuberculous sputum and can carry and distribute *Bacillus tuberculosis* for several days, he contends that whether they are serious factors in the spread of the disease remains to be proved.

Concerning the organisms of other bacterial diseases, especially ophthalmia, he states that these may be distributed by flies, but little definite evidence on the subject is available.

It is surely not the intention of Dr. Graham-Smith to underestimate the danger from flies, although his book read by the unscientific eye may produce this effect on the unscientific mind. He closes with a strong plea for careful additional observations and investigations. For the elucidation of some of the problems, while expert knowledge is required, he states that accurate observations by workers without especial scientific training will be of the greatest assistance.

The book as a whole is an excellent one. I wish that the writer might have displayed more of the arguments against flies that are not founded upon definite bacteriological examinations; but there are other books that do that, and this one is a reliable one to have

on the desk to consult from time to time upon questions of exact fact. The interest in this line of investigation is so intense at present that it is perfectly obvious that enough new facts will be accumulated in another season to warrant the adding of several chapters.

L. O. Howard

The Progress of Scientific Chemistry in Our Own Times. By Sir William A. Tilden. New York, Longmans, Green and Co. 1913. Second edition. 15 × 20 cm. Pp. v + 366. Price, $2.25 net.

The period covered by the book is from 1837 to the present. The first date was selected because Queen Victoria then came to the throne, while the scientific justification might be that at that time the influence of Liebig's teaching was beginning to be felt. After the usual preliminary chapter on Lavoisier, Cavendish, Dalton and Berzelius, we get to the book proper. We start with the conservation of energy and Joule's determination of the thermodynamic equivalent of heat. This leads at once to Hess's law of thermochemistry, to the experiments of Julius Thomsen, to Berthelot's enunciation of his principle of maximum work, and to St. Claire Deville's work on dissociation. The second chapter—which perhaps should have been the first—deals with the distribution of the chemical elements and the recognition of them by the chemist. This, of course, involves Bunsen and Kirchhoff's work on spectrum analysis, the discovery of argon by Rayleigh and Ramsay, and the isolation of the other noble gases by Ramsay. The elements being given, the third chapter deals with the determination of the atomic weights, including the theoretical reforms of Cannizzaro and the experimental researches of Dumas, Stas and others. The work of Gerhardt, Laurent and others on types is also taken up in this chapter. This seems a mistake because the work has to be discussed later in its proper place. The justification for its inclusion at this point seems to be that it was necessary in order to determine the atomic ratios of carbon to hydrogen and oxygen. While this is doubtless true historically, it would have been more artistic to have passed over this difficulty gracefully and thus to have avoided repetition.

Once we have the atomic weights determined, we are confronted with Prout's hypothesis. The third edition will undoubtedly contain the account of the resurrection of this hypothesis by Rutherford, but only a prophet could have included that in this edition. After Prout's hypothesis has been disposed of, the remainder of the fourth chapter is devoted to Mendeléeff's periodic law and its developments. The question of constitutional formulas comes up in the fifth chapter, which carries us through the work of Kekulé. The fruitfulness of Kekulé's conception is brought to our minds clearly in the account of synthetical organic chemistry in the sixth chapter. In the seventh chapter we have Pasteur's work on optically active substances, and the theory of stereochemistry as developed by van't Hoff and Le Bel. The next step, historically and logically, is from the problem of the molecular structure to that of chemical affinity, and the eighth chapter is consequently devoted to a discussion of electricity and chemical affinity.

Up to this point, the treatment has been logical and coherent; but the ninth chapter is an intercalated one on the liquefaction of gases. There is no conceivable reason for introducing this chapter at this point except that the author perhaps did not know where else to put it. As a matter of fact it should have come in just before the account of Ramsay's isolation of the noble gases of the atmosphere. Presumably it was not put there because the author wished to discuss the liquefaction of helium, which he could not do until he had introduced helium to his audience. He should however have discussed the general problem of the liquefaction of gases as an introduction to Ramsay's work and he could then have taken up the liquefaction of helium as a special fact under the general properties of helium.

If this had been done, we should have passed directly from the chapter on chemical affinity to that on radioactivity. The loose ends are gathered up in a final chapter which includes

remarks on photochemistry, colloids and research work in Great Britain. Altogether this is a very readable book and all the more so because of the continuity of plan, which is quite unusual. Most writers of historical outlines content themselves—or are forced to content themselves—with isolated chapters. It is really quite a feat to have avoided this danger to so great an extent as Sir William Tilden has done.

The reviewer is entirely in sympathy with the contention, in the preface, that students should not only know the names of the leaders of scientific thought, but should perceive correctly the connection between their discoveries and the general progress of their science. In order to bring this about, a series of biographical notes has been appended to each chapter. In these notes are given a brief sketch of the life and work of every deceased chemist or physicist who has contributed substantially to the progress thus far accomplished.

WILDER D. BANCROFT

BOTANICAL NOTES

PROTOCOCCUS, NOT PLEUROCOCCUS

IN a recent number of *Nyt Magazin for Naturvidenskaberne* (Christiania) N. Wille gives the results of his studies of the actual specimens of certain lower green algae prepared by C. A. Agardh, and still preserved in the herbarium of the University of Lund, Sweden. One outcome of these is the settlement of the question as to whether or not the name *Protococcus* is still valid. As every teacher knows there has been a strong tide against the use of the name *Protococcus* for the common green slime of tree-trunks and walls, the preferred name being *Pleurococcus*. In the paper under consideration the author first gives a summary history of the nomenclatural tangle which has arisen. In 1824 C. A. Agardh named a certain plant *Protococcus viridis*. In 1842 J. Meneghini, not knowing Agardh's plants, proposed the name *Pleurococcus*, and included blue-green as well as green species, and among the latter he included the plants named *Protococcus viridis* by Agardh. Other forms of confusion resulted from this initial blunder of Meneghini's but what is here given is sufficient to warrant Wille's conclusion:

> It is clear that in order to disentangle such a confused mass of synonyms one must go back to the original specimens to determine what C. A. Agardh really understood by his species *Protococcus viridis*.

So he examined the original specimens and found that the specimens labeled *Protococcus viridis* are what later authors have called *Pleurococcus*. This fact requires, as Wille says, that "this species must therefore be called *Protococcus viridis*."

Since *Pleurococcus* was used by Meneghini for blue-green and also green algæ that name is left badly discredited, and must doubtless fall into synonymy.

SHORT NOTES

SOME recent systematic papers are: A Consideration of Structure in Relation to Genera of Polyporaceae, by Doctor Adeline Ames (*Ann. Mycol.*, Vol. XI.), including a key to, and descriptions of sixteen genera, with four half-tone plates; New Fucaceae, by N. L. Gardner (Calif. Univ. Pub., Vol. 4), containing descriptions of some western rockweeds and their close allies, and accompanied by eighteen half-tone plates of excellent photographs of the plants described.

BULLETINS 284 and 285 of the Bureau of Plant Industry of the U. S. Department of Agriculture on the Water Requirement of Plant deal with some of the scientific facts that underlie the practical aspects of agriculture. In the first the joint authors, L. J. Briggs and H. L. Shantz, report in detail upon their investigations made at the dry-land experiment station at Akron, in northeastern Colorado, in the years 1910 and 1911. The bulletin is a valuable contribution to the physiology of the water loss sustained by plants under arid conditions. In the second bulletin the same authors have rendered a most welcome service to plant physiologists by presenting in summary form a review of the literature of the water requirement and water loss

of plants. These summaries are so systematically arranged that they must prove of the greatest help to plant physiologists.

ALLIED to the foregoing is Dr. F. J. Alway's paper, "Studies on the Relation of the Non-available Water of the Soil to the Hygroscopic Coefficient" (Research Bull. No. 3, Agr'l. Expt. Station of Nebraska).

AMONG the recent pathological papers are: M. T. Cook's Report of the Pathologist for the year 1912 (N. J. Expt. Station) enumerating especially the diseases of the year; Ethel Field's Fungous Diseases Liable to be Disseminated in Shipments of Sugar Cane (Circular 126; Bureau of Plant Industry, U. S. Dept. Agric.); Adeline Ames's New Wood-Destroying Fungus (*Bot. Gaz.*, May, 1913); P. J. O'Gara's Studies on the Water Core of Apples (*Phytopathology*, April, 1913), and Organization and Methods of Control of Plant Diseases (Wash. State Hort. Assn., 1913).

HERE may be mentioned H. R. Cox's paper, "Controlling Canada Thistles" (Farmer's Bulletin 545, U. S. Dept. Agr.), containing a good deal as to the biology of these weeds, as well as practical suggestions as to how they may be eradicated.

HERE too should be noted O. F. Cook's "Wild Wheat in Palestine" (Bull. 274, Bureau of Plant Industry, U. S. Dept. Agric.), describing "a new type of wheat growing in a wild state" in Palestine. Though this paper "does not attempt to reach a final decision on the question whether the wild wheat of Palestine is the true ancestor or prototype of the domesticated varieties of wheat," it does serve to bring out "several additional facts regarding the character and habits of the plants."

THE NEW VOLUME OF THE SYLLOGE FUNGORUM

QUITE recently the twenty-second volume of this work reached American subscribers. It is a continuation of the "Supplementum Universale" of the twenty-first volume, and includes the descriptions of added species of fungi to the end of the year 1910. Like the volume immediately preceding, it is the joint work of P. A. Saccardo and Alex. Trotter. It is devoted to the Ascomyceteae (pp. 1–822) and Deuteromyceteae (pp. 823–1505). A Repertorium of 24 pages, an Alphabetical Index of species (69 pages), and an Index of Genera (13 pages) close the volume.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

THE SOLAR SPECTRUM AND THE EARTH'S CRUST

PROFESSOR ROWLAND'S list of the elements whose lines appear in the solar spectrum has long been a classic work of reference among astronomers, and Dr. F. W. Clarke's summary of the chemical composition of the earth's crust occupies a similar position among geologists. Each list has been thoroughly discussed, by various writers, from the standpoint of the science to which it belongs; but little attention seems to have been called to the striking resemblances between the two.

In the annexed table are given (1) Rowland's list of the elements whose dark lines appear in the integrated spectrum of the sun, arranged in the order of the combined intensity of the lines of each element, as quoted in Abbot's "The Sun," p. 91 (1911); (2) a similar list of the elements, arranged in the order of the intensity of their bright lines in the spectrum of the solar atmosphere, as photographed at the total eclipse of 1905 by S. A. Mitchell[1]; (3) Clarke's table of the percentage composition of the outer ten miles of the earth's substance, including the lithosphere, hydrosphere and atmosphere,[2] and (4) the average composition of ninety-nine stony meteorites, as derived by G. P. Merrill from published analyses.[3]

[1] *Astrophysical Journal*, 38, 407–495, and 39, 166–177, 1913–14.

[2] As given by him in Bulletin 491 of the U. S. Geological Survey, pp. 27–33, with additional data from papers in the *Proceedings of the American Philosophical Society*, Vol. 51, p. 220, 1912, and the *Journal of the Washington Academy of Sciences*, Vol. 4, pp. 59–62, 1914.

[3] Quoted by Clarke on p. 39 of the work first cited.

Solar Spectrum, Dark Lines (Howland)		Chromosphere, Bright Lines (Mitchell)	Earth's Crust, Outer 10 Miles (Clarke)		Stony Meteorites (Merrill)	
1	Ca	Fe	O	49.85%	O	35.75%
2	Fe	Ti	Si	26.03	Fe	24.52
3	H	H	AL	7.28	Si	18.20
4	Na	Cr	Fe	4.12	Mg	13.80
5	Ni	Ca	Ca	3.18	S	1.85
6	Mg	V	Na	2.33	Al	1.45
7	Co	Sc	K	2.33	Ca	1.25
8	Si	Zr	Mg	2.11	Ni+Co	1.32
9	Al	C	H	0.97	Na	0.70
10	Ti	Mn	Ti	0.41	Cr	0.34
11	Cr	Mg	Cl	0.20	K	0.27
12	Sr	Ni	C	0.19	P	0.11
13	Mn	Ce	P	0.10		
14	V	Nd	S	0.10		
15	Ba	He	F	0.10		
16	C	Co	Ba	0.09		
17	Sc	Y	Mn	0.08		
18	Y	Sr	Sr	0.03		
19	Zr	Ba	Cr	0.025		
20	Mo	La	Ni+Co	0.018		
21	La	Sa	V	0.015		
22	Nb	Al	Zr	0.013		
23	Pd	Er	Cu	0.010		
24	Nd	Gd	Zn	0.004		
25	Cu	Na	Li	0.004		
26	Zn	Si	Pb	0.002		
27	Cd	Eu	Br	0.0006		
28	Ce	Zn	As	0.0004		
29	Gl	Dy	Cd	0.00002		
30	Ge	Cu				
31	Rh	Pr	Allowance for all other elements 0.38			
32	Ag	Nh				
33	Sn					
34	Pb					
35	Er					
36	K					

All these lists are doubtless incomplete at the lower end. Later researches have shown that oxygen, gallium, ruthenium and all the rare earths given in Mitchell's list, should be added to Rowland's table, raising the number of elements represented to forty-five. The presence of nitrogen is also indicated by the appearance of the cyanogen bands, but not by its own lines. Photographs showing fainter lines would probably considerably extend the list of elements recognizable in the flash-spectrum. The list of elements in the earth's crust is certainly very incomplete below those which form 0.01 per cent. of the total. If carried out to the limit it should of course include all the elements, and it is not yet known what positions some of them, such as the rare earths, would occupy in a complete scheme. The list for the stony meteorites is probably far from exhaustive, and it is not safe to draw conclusions from the failure of some elements to appear in it. It may be added that, according to Farringdon,[4] the average percentage of nickel in meteoric irons is about 7.5, and that of cobalt about one tenth as much, while that of copper averages about 0.02. It would therefore seem reasonable to suppose that the amounts of "Ni + Co" given in the table should be divided between the two metals in about this ratio.

Upon comparing the lists of Rowland and Clarke, we meet at once the fact—one of the commonplaces of astrophysics—that the non-metallic elements, with the exception of carbon and silicon, are scarcely if at all represented in the solar spectrum. The only one whose lines appear is oxygen—which is from 20 to 100 times more abundant in accessible materials than all the others put together (excepting C and Si, as above). If we simply accept this fact (which is still without adequate explanation), and exclude these non-metallic elements from the comparison, the similarity between the order of the remaining elements in the two lists is remarkable.

Of the eight metallic elements (including carbon and silicon under this head for the moment) which are most abundant in the earth's crust, six are among the eight whose lines are strongest in the solar spectrum, and one of the other two comes ninth in the solar list. Of the next eight metallic elements in the terrestrial list, seven are found among the second group of eight in the solar list, and the other one (Ni) is among the first eight. That is, fifteen of the sixteen leading metallic elements are common to the two lists, and there is a general similarity in their relative order in the two.

Beyond this point comparison becomes hardly practicable, as the terrestrial list is probably incomplete. Four of the next eight elements in Rowland's list are rare earths, for which there are as yet no sufficient analytical

[4] Publications of the Field Columbian Museum, Geological Series, Vol. 3, No. 5, p. 110.

data. It is clear, however, that the elements whose lines are faint in the sun are, in general, present in but very small proportions in the earth's crust.

It is very remarkable that the correspondence of the two lists is so close, in view of the radical differences in the methods of investigation, and the great differences in the relative intensities of the lines in stellar spectra of different types. Even in the bright-line spectrum of the solar atmosphere, the similarity is by no means as pronounced.

Out of the first sixteen elements in either list, only one, barium, has an atomic weight exceeding 100, and but one other, strontium, one greater than 60. The significance of this fact has frequently been discussed by geologists or by astronomers.[5] In both cases it has been suggested that the heavier elements lie for the most part deep within the body, and out of reach; but Clarke gives good reasons for believing that, even in the earth's interior, the lighter elements are more abundant than the heavier. This suggests that the faintness or absence of the lines of the heavier metals in the solar spectrum may be due largely to the small proportions in which they occur, and some confirmation of this is found in the fact that, of the elements of atomic weight greater than 180, only lead, which is the most abundant in the earth's crust, appears at all in the sun. But the rarity of these elements can not be the whole explanation of their absence from the solar spectrum, for although no lines of Os, Ir or Pt occur in it, the stronger lines of the equally rare elements Ru, Rh and Pd (whose atomic weights are about half as great) appear distinctly, though faintly.

The element which is most disproportionately conspicuous in the sun, in comparison with its terrestrial abundance, is cobalt. Nickel too is relatively high on the solar list. This may be partly explained by the great number of lines in the spectra of these elements, which gives them undue weight in a spectroscopic count. It is also worthy of notice that, if 25 per cent. of meteoric iron were added to a sample of the earth's crust, and the composition of the resulting mixture considered, iron would occupy the first place among the metallic elements, nickel the eighth, and cobalt the eleventh, and the discordance with the solar list would disappear. Of the elements abundant in the earth, and relatively less conspicuous in the sun, silicon apparently approaches the typical non-metallic elements in its behavior, while aluminium has only four lines in the observable region, and is thus handicapped by the spectroscopic method of detection.

The principal differences in the order of the metallic elements in the two lists are therefore easily explicable, with one conspicuous exception. Potassium, which is one of the principal constituents of the earth's crust, and is fairly abundant in meteorites, shows as the merest trace, if at all, in the solar spectrum, although many strong lines, both of the principal and the subordinate series, lie in the observed region. Their absence, in spite of the presence of conspicuous lines of elements which are far less abundant in terrestrial materials, is remarkable, and would seem to demand some special explanation. It is of interest in this connection that potassium, alone among the more common elements, is slightly radio-active. If this indicates that its atoms are relatively unstable, they might break down under solar conditions; but this is a highly speculative consideration. The lines of the more strongly radio-active elements do not appear at all in the solar spectrum; but this may be accounted for by their extreme rarity (on earth, at least) and their high atomic weights. It should however be mentioned that lithium, which is next to potassium in abundance among the alkali metals, and occurs in sensible proportions in the earth's crust, but, so far as is known, is not radio-active, is also practically absent from the solar spectrum—though Adams[6] points out that a very faint line, greatly strengthened in sun-spots, at wave-length 6708.08 may represent the strongest line in the lithium spectrum.

[5] Compare Clarke, *op. cit.*, p. 33, and Abbot, "The Sun," pp. 92–94, 253–254.

[6] *Astrophysical Journal*, Vol. 30, p. 92, 1909.

In spite of these exceptions, the agreement of the solar and terrestrial lists is such as to confirm very strongly Rowland's opinion that, if the earth's crust should be raised to the temperature of the sun's atmosphere, it would give a very similar absorption spectrum. A moderate admixture of meteoric material would make the similarity even closer.

In conclusion, the writer desires to express his very hearty thanks to Dr. Clarke, for valuable information on the geochemical side of the problem, and for the suggestion that the comparison here made (which has been given in the writer's lectures for several years) may contain enough that is unfamiliar to justify its publication.

HENRY NORRIS RUSSELL
PRINCETON UNIVERSITY OBSERVATORY,
May 5, 1914

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION K—PHYSIOLOGY AND EXPERIMENTAL MEDICINE

AT 4:30 o'clock on the afternoon of Friday, January 2, 1914, Section K met at the Atlanta Medical College, Atlanta, Georgia, with Vice-president Theodore Hough in the chair. The address of the retiring Vice-president, Dr. John J. R. Macleod, entitled, "The Physiological Instruction of Medical Students," was read by title owing to the lateness of the hour.

The Section then began the symposium on the subject of pellagra. The first speaker, Dr. J. W. Babcock, superintendent of the State Hospital for the Insane, at Columbia, S. C., spoke on the "Medico-Legal Relations of Pellagra." Dr. Babcock has not sent to the secretary an abstract of his remarks.

Captain J. F. Siler, of the U. S. Army Medical Corps, Dr. P. E. Garrison, U. S. N., and Dr. W. J. MacNeal, assistant director of laboratories, New York Post-Graduate Medical School, presented a paper read by Dr. MacNeal entitled, "Further Studies of the Thompson-McFadden Commission on the Etiology of Pellagra." An abstract follows.

"The Entomological Aspects of the Pellagra Investigation of the Thompson-McFadden Commission" was presented by Mr. A. H. Jennings, of the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Report of the Thompson-McFadden Pellagra Commission:

Information concerning the age and sex, occupations, location of domicile, general dietary habits and concerning the existence of pellagra was obtained upon about five thousand persons by a house-to-house canvass of six cotton-mill villages. A similar study was carried out in one rural district of four square miles in which several cases of pellagra had occurred. Many other communities were studied in less detail. There was no definite relation observed between the occurrence of pellagra and the use of any particular foods. New cases developed for the most part in the immediate vicinity of old cases or after close association with them. In districts completely equipped with water carriage systems of sewage disposal, we found pellagrins who had acquired the disease before moving to these districts. Cases apparently originating in these sewered districts were extremely rare and their origin there somewhat doubtful.

These observations strongly suggest that unsanitary methods of sewage disposal have an important relationship to the spread of pellagra. If these indications can be confirmed in other places, we feel that the proper correction of these conditions by the installation of water carriage systems of sewage disposal will go far toward restricting the spread of the disease.

The exact mode of transmission of pellagra is still uncertain and we strongly urge the continued study of food contamination, of insects as transmitting agents and of close personal association as possible factors in its spread.

Summary of Two Years' Study of Insects in Relation to Pellagra: ALLAN H. JENNINGS.

The results of a study by the writer and W. V. King, in cooperation with the Thompson-McFadden Pellagra Commission in Spartanburg county, S. C., are here summarized, the observations and conclusions referring to conditions in that region except where otherwise stated.

Infectiousness of the disease and its transmissibility by blood-sucking insects were assumed, purely as a necessary basis for our work.

A high percentage of female cases, especially among home-frequenting individuals and among children of both sexes is a marked characteristic of the disease, a transmitter which is active by day being thereby indicated.

The characteristics of the insects studied justify

the incrimination of the biting stable fly, *Stomoxys calcitrans*, alone. These characteristics and the species studied are given below.

The distribution of pellagra and its occurrence in persons seemingly not exposed to attack by lice, possibly, also, the sex incidence, are not satisfactorily explained by their incrimination.

Bed bugs, though abundant, fail to account for the sex incidence of pellagra, while the habits and scarcity of horse-flies exclude them.

The prevalent mosquitoes, *Culex quinquefaciatus* (=*fatigans*) are nocturnal in habit and the day-biting *Aedes calopus* is of irregular occurrence in the region.

The human flea, *Pulex irritans*, is rare or wanting in the county. Fleas of animals cause little annoyance and they do not explain the sex incidence.

Simulium species do not associate with man and pellagra sufferers are usually rarely exposed to their attack. They are negligible as a pest of man in the region. Pellagra occurs, also, in regions from which they are absent.

Sand flies (Chironomidæ), if present, are not a pest in the region.

The stable fly is a practically cosmopolitan and abundant species; it associates with man, invades his dwellings and attacks him freely; it bites by day and its longevity is considerable. Human blood has been determined in the stomachs of an important percentage of individuals and human blood may be drawn without pain, in many instances.

If the cause of pellagra is an intestinal bacterium, the house fly may very probably be a vehicle for its diffusion.

The house-infesting roaches, in this event, may also play a minor part.

Discussion of Pellagra—Mental Disturbances: E. BATES BLOCK, M.D.

There is no one type of mental disturbance characteristic of pellagra. Insanity is usually a late manifestation of the disease and when it occurs it usually means that the end is near. As a terminal event it usually assumes the type of the infective exhaustive psychoses, with clouding of the consciousness, confusion, hallucinations and changing delusions, with marked restlessness and apprehensiveness.

When the insanity occurs earlier in the disease before the exhaustion becomes marked, it is usually characterized by great depression with delusions which are depressive or persecutory in character. This is associated with marked apathy or restlessness and general nervousness and insomnia, and sometimes with excruciating headaches. Mental confusion is quite common; apprehensiveness is often a marked feature of the disease. Suicidal attempts are quite common, but in only one of the cases which I have seen has there been any violence towards others.

Sometimes the insanity precedes the physical signs of pellagra as a part of the disease. While insanity does not confer immunity to pellagra and the sequence may have been accidental, I have seen several cases which have developed insanity suddenly and were so shortly followed by symptoms of acute pellagra that I believed them to be a part of the same disease. One of these was apparently typically psychasthenia, another melancholia, while a third was apparently manic depressive insanity, but all were quickly followed by the typical signs of pellagra. The prognosis in these cases is much more favorable than in the cases in which the insanity developed as a late manifestation of the disease. Occasionally the apathy is so great as to suggest dementia præcox and the cases of this type that I have seen have run a very chronic and protracted course.

The development of insanity is not necessarily of fatal significance. In one of my cases the patient has remained perfectly well now for eight years and in another for five years, without any recurrence either of mental or physical symptoms.

The *prognosis of pellagra* was discussed by Dr. George M. Niles, of Atlanta, Ga., as follows:

My experience in the treatment of over six hundred cases of this malady has made me somewhat optimistic, and I feel that the attitude of extreme pessimism assumed by some observers is unjustified.

Pellagra, like some other diseases, seems more virulent when implanted on virgin soil. We note that in the Old World, where it has been rife for nearly two centuries, the mortality is not near so great. In this country it is in many respects a new enemy, and its prospective victims have not been able to establish, as it were, any form of immunity against its ravages.

In my professional intercourses with pellagrins and their inquiring friends I have adopted a classification as to the conditions in which a favorable outcome may be anticipated, or the reverse. There are four classes in whom I am extremely chary in holding out a favorable prognosis: First, pellagrins over fifty or fifty-five years of age. The pathologic changes of this disease closely simulate those of senility, and when to the changes

due to weight of years are added like burdens due to disease, Nature can not hope to successfully contend with both. Second, confirmed alcoholics. These unfortunates seldom recover from pellagra. Third, cases in which the mentality is seriously impaired. These psychic changes indicate marked destruction of important nerve centers, and render the prognosis doubtful. Fourth, that class of intellectual weaklings who have neither the intelligence nor pertinacity to faithfully hold to and observe a course of treatment for months or years, if necessary, but who are continually shifting from one to another, or taking the nostrums of quacks and charlatans. Practically all of this fourth class succumb.

On the other hand, those who are not included in the classes just mentioned, who will zealously and patiently carry out the medicinal, dietetic and hygienic rules of those physicians who are experienced in the care of such cases, the hope of ultimate and permanent recovery may be confidently grasped by the large majority.

Let me in closing admonish my hearers that the keynote in the treatment of pellagra is *optimism*. If the patient can be kept in good spirits, and in a consistently hopeful frame of mind, the higher centers, untrammelled by fears or obsessions, can best exert their beneficent influence over the lower centers, vegetative and otherwise, and with a brighter hope of victory can we combat this dreaded scourge.

L. O. Howard,
Secretary pro tem.

THE AMERICAN PHYSICAL SOCIETY

A regular meeting of the Physical Society was held at the Bureau of Standards, Washington, April 24 and 25, 1914. This was a joint meeting with the electrophysics committee of the American Institution of Electrical Engineers. The programs of the two morning and of the Saturday afternoon sessions were in charge of the Physical Society with President Merritt in the chair. The Friday evening session was in charge of the A. I. E. E. with Chairman J. B. Whitehead in the chair. The Friday afternoon session was given to a lecture by Sir Ernest Rutherford, F.R.S., of the University of Manchester, Eng., "On X-ray and Gamma-ray Spectra," complimentary to the American Physical Society.

Special features of the meeting were the opening of the new electrical building of the Bureau of Standards and an exhibit of physical apparatus. This exhibit was arranged under the direction of a committee of the American Physical Society with Dr. F. A. Wolff as chairman. It was a large and representative exhibit, participated in by thirty-two manufacturers, importers and industrial research laboratories, ten universities and educational institutions, and eight federal scientific bureaus.

Members of the Physical Society were especially invited by the National Academy of Sciences to attend the William Ellery Hale lectures by Sir Ernest Rutherford, F.R.S., upon "The Constitution of Matter and the Evolution of the Elements." These were given in the auditorium of the National Museum on April 21 and 23, and were attended by a large number of the Physical Society members.

All in attendance at the meetings were the guests of the scientific staff of the Bureau of Standards at luncheon on both days of the meeting. After the Friday evening session the local branch of the A. I. E. E. gave a smoker which was largely attended.

At a short business session of the Physical Society the following items of business were transacted:

On recommendation of the council, it was voted to establish a new grade of foreign members, to be defined as non-residents of North America, to pay dues of \$4.00, with no initiation fee and to receive the *Physical Review* (with *Science Abstracts* on additional payment of \$2.00) and having all rights of regular members in the society. Also, to make such changes in the by-laws as the establishment of this new grade of membership would necessitate.

On motion it was voted to approve and authorize an International Congress of Physics to be held in Washington in October, 1915, in case it should appear that it can be properly financed. (A committee of nine was appointed by the Council to determine this question).

It was voted that the president appoint a committee of three to express the deep sense of loss felt by the members of this society in the death of their former president, Professor B. O. Peirce.

The society voted to express to the director and members of the National Bureau of Standards its high appreciation of the generous hospitality extended to the society throughout the meeting, also to the Washington Section of the American Institute of Electrical Engineers for arranging trips and providing guides to various places of scientific interest in the city and its neighborhood.

The program of scientific papers was as follows:

"Solenoids," by C. R. Underhill.

"Some Investigations of Lightning Protection for Buildings," by DeBlois.

"A Milli-Ampere Current Transformer," by Edw. Bennett.

"Some Simple Examples of Transmission Line Surges," by W. S. Franklin. (By title.)

"Theory of the Corona," by Bergen Davis.

"High Temperature Measurements with the Stefan-Boltzmann Law," by C. E. Mendenhall and W. E. Forsythe.

"Cold-end Compensator for Thermocouples," by Charles B. Thwing. (Apparatus shown.)

"The Emissivity of Metals and Oxides. I.; Nickel Oxide (NiO) in the Range 600° to 1,300° C.," by G. K. Burgess and P. D. Foote.

"Formulæ for the Ordinary Mercury Contact Thermostat, and Some Practical Conclusions Deduced from Them," by W. P. White. (By title.)

"The Specific Heats of Mixtures of Water and Alcohol, and of Solutions of Non-Electrolytes in these Mixtures," by W. F. Magie.

"The Extension of the Spectrum in the Extreme Ultra-Violet," by Theodore Lyman.

"The Infra-red Arc Spectrum of Barium," by H. M. Randall.

"On the Growth and Decay of Color Sensation," by M. Luckiesh.

"Some Effects of Diffraction on Brightness Measurements made with the Holborn-Kurlbaum Optical Pyrometer," by A. G. Worthing and W. E. Forsythe.

"Further Experiments on the Use of the Photo-electric Cell in Stellar Photometry," by Jakob Kunz, J. Stebbins and W. F. Schulz.

"Displacement of Arc Lines not Due to Pressure," by Chas. E. St. John and H. D. Babcock.

"On the Accuracy of Terrestrial-magnetic Measurements," by L. A. Bauer.

"The Gamma-ray Comparison of Specimens of Radium Salts," by N. Ernest Dorsey.

"Note on the Photo-electric Effect with Potassium Surfaces in Very High Vacuum," by Saul Dushman.

"The Results of the Atmospheric Electric Observations on the Second Cruise of the *Carnegie*, June, 1910, to December, 1913," by C. W. Hewlett.

"Apparatus for the Spectroscopic Synthesis of Color," by H. E. Ives and E. J. Brady.

"New Methods for Measuring Time Constants of Low Resistances," by Frank Wenner, Ernest Weibel and F. B. Silsbee.

"A Sensitive Moving Coil Galvanometer," by F. Wenner, E. Weibel and F. O. Weaver.

"Some Records of the Wireless Time Signals Made with a Physiological Recorder," by C. W. Waggoner.

"Electric Conduction and Thermo-electric Action in Metals," by E. H. Hall.

"Electrochemical Indicators and Recorders. Instruments for Showing Continuously the Chemical Content of Solutions," by F. A. Harvey.

"Characteristic Curves of Tungsten Filament Incandescent Lamps and their Application in Heterochromatic Precision Photometry," by G. W. Middlekauff and J. F. Skogland.

"The Thomson E.M.F. in and the Thermal Conductivity of Tungsten at Incandescent Temperatures," by A. G. Worthing.

"A Direct Determination of h," by R. A. Millikan.

"Some Peculiarities in the Thermal Expansion of Invar," by Arthur W. Gray.

"A New Turbidimeter," by P. V. Wells.

"The Diurnal System of Convection," by Wm. H. Blair.

"The Control of the Wave-length Sensibility Curves for Selenium," by E. O. Dieterich.

"On the Relation between the Photo-electric Potential and the Frequency of Light for Potassium," by S. Karrer.

"Reflection and Scattering of Slow-moving Electrons," by Albert W. Hull.

"Reversible Transitions between Solids at High Pressures," by P. W. Bridgman.

"Surface Leakage over Insulators," by H. L. Curtis.

"Spark Potentials in a Magnetic Field," by R. F. Earhart. (By title.)

"Some Points with Regard to the Variation of the Specific Magnetization of a Substance with Temperature," by W. F. G. Swann.

"High Frequency Verification of Kirchoff's Capacity Formulæ," by F. C. Blake and Chas. Sheard. (By title.)

"Corona Produced by Continuous Potentials," by S. P. Farwell.

"A Significant Instance of Galvanometer Instability," by W. P. White.

"Wave-length Sensibility Curves of Potassium Photo-electric Cells," by H. E. Ives.

"An Electromagnetic Puzzle," by F. J. Rogers.

"The Photo-electric Effect of Carbon as Influenced by its Absorbed Gases," by Otto Stuhlmann, Jr., and R. J. Piersol.

"The Relation of Residual Gases to the Photo-electric Sensitiveness and the Contact E.M.F. of Sodium," by R. A. Millikan and W. H. Souder.

"Effect of Glass Walls on Thermionic Currents," by Saul Dushman.

"A New Design of Flicker Photometer for Laboratory Colored-light Photometry," by H. E. Ives and E. J. Brady.

"Note on the Physiological Effect of the Current," by F. J. Rogers.

"Examples of the Precision Attainable in Determinations of Thermal Expansivity," by Arthur W. Gray.

"Dioptric Formulæ for Combined Cylindrical Lenses at Oblique Axes," by Charles Sheard. (By title.)

"The Testing of Potentiometers," by Frank Wenner and Ernest Weibel.

"An Absorbing Solution for Eliminating Color Differences in Photometry," by H. E. Ives and E. F. Kingsbury.

"Photographs of Retrograde Rays, (a) from the Cold Cathode, (b) from the Hot Lime Cathode," by O. H. Smith.

A. D. Cole,
Secretary

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

II

THURSDAY, JANUARY 1, 1914

Systematic Bacteriology

Morphology of the Bacteria (Vibro and Spirillum), An Early Research: Joseph Leidy, Jr.

This paper will be published in Science.

The Classification Card and the Type or Study which it Merits: H. A. Harding.

The classification card has not appealed to the pathologists, because they could test unknown cultures more quickly on animals, nor to water bacteriologists because their attention has been focused upon *B. coli* and special media, but it has been very valuable to students of bacterial ecology. The card is justly criticized because the observations of bacterial cultures are not always accurately recorded by it and because the present group number is unwieldy and of undetermined value as a basis for classification. One of the most urgent demands of bacteriology to-day is the careful testing out of various suggestions looking toward an improved technique. Dr. H. J. Conn has suggested that the ease of handling the group number can be increased by pointing it off into periods of about three figures each. The significance of such periods would be increased if each was devoted to a class of reactions such as morphology, fermentation, nitrogen relations and enzyms. The reactions should be selected for this group number after careful study of their accuracy and utility, and pending the results of this study the card of 1907 should be retained practically unchanged.

Constancy in the Fermentative Activity of Streptococci: Jean Broadhurst.

Attempts to correlate the fermentative results of different workers in saccharose mannit and other Gordon media have led to a series of experiments dealing with the different conditions characterising the technique in different laboratories. Differences, such as acidity, presence or absence of sugars, subjection to raw and variously heated milks, were tried out without finding any definite results on the later Gordon reactions. Slight and brief increases in temperature (above 37°) depressed fermentative activity decidedly. Much more marked (as previously reported) were the contrasts resulting from the use of meat extract and of meat Gordon media. These effects are evidently not necessarily lasting. Permanent changes were effected by a stay in the alimentary canal (*e. g.*, a gain in lactose in dogs fed on streptococci-free milk). Cultures kept for 1 to 4 months on meat agar (10-day transfers) showed a gain in the amount of fermentative activity (the amount of acid), many strains show also a gain in the number of substances fermented; less often a loss occurred in the number of substances fermented. Studies carried on with individual animals for varying periods (2–10 mo.) showed unexpectedly wide ranges in the physiological types of mouth and fecal streptococci, affecting probably the diagnostic value of fermentative reactions. These, and other phases of the work reported upon, seem to warrant the following conclusions: (1) Constancy may be claimed for streptococci under identical or duplicate conditions. (2) Constancy in these fermentative responses is also characteristic of a large percentage of strains, under varying or varied conditions. Age, a stay in the alimentary canal, and meat extract, have more effect on such results than any of the (19) varied conditions tried.

The Relation of Habitat and Physiological Characters in the Streptococci: L. A. Rogers and Arnold Dahlberg.

It is reasonable to assume that true species in the bacteria will be found associated with a definite habitat as it is with the higher plants and animals. Studies were made of the physiological characters of 51 cultures from infected udders; 114 cultures from bovine feces; 31 cultures from

the mouths of cows and 42 cultures from milk obtained by selecting cultures showing chains in lactose bile at 37°. The morphology varied under different conditions but the udder cultures showed the most uniform and consistent chain formation. The cultures from the several sources differed in the amount of acid formed in dextrose broth, those from the mouth giving the highest acidity and those from the udder the lowest. The milk cultures were slightly higher than those from the udder. The udder cultures would be divided into two distinct groups, one of which fermented dextrose, saccharose and lactose and occasionally mannite and agreed with the published descriptions of strep. pyogenes. The second group frequently liquefied gelatin and in addition to dextrose, saccharose and lactose, usually fermented the alcohols mannite and glycerine. The cultures from feces were particularly uniform in their reactions, fermenting dextrose, saccharose, lactose and raffinose and frequently the polysaccharides starch and inulin, but failing to ferment the alcohols or liquefy gelatin. The cultures from the mouth differed from those from the udder in the higher percentages of raffinose, inulin and mannite fermenters and in less action on glycerine and gelatin. They are sharply differentiated from the feces organisms in their general failure to ferment starch and in the much higher percentage of mannite fermenters. Two of the milk cultures evidently belong with the feces group. All others may be placed in one of the two udder groups.

The Significant Characters of the Colon Group Isolated from Cow Feces: L. A. ROGERS, WM. M. CLARK AND ALICE C. EVANS.

Previous work on a collection of the colon type from milk demonstrated that the gas ratio and volume are constant under uniform conditions; that, on the basis of the gas ratio and volume, the cultures may be divided into two distinct groups and that the correlation of the fermentative ability with the gas ratio makes this distinction sharply defined.

This paper records the results of a similar study on 150 cultures isolated from bovine feces. None of these cultures liquefied gelatin and all but one found indol from tryptophane. By the use of a simple medium and exact methods of analysis it was found that in 149 cultures the $CO_2:H_2$ ratio varied from 0.98 to 1.20 only. One culture only gave a ratio identifying it with the high ratio group which made up 48 per cent. of the milk series. The 149 low ratio (0.98–1.20) cultures were readily divided into two groups, one of which fermented dextrose, saccharose, lactose, raffinose, mannite, glycerine and dulcite, but almost invariably failed to ferment starch, inulin and adonite, while the second group ferments dextrose, lactose, mannite and glycerine, occasionally ferments adonite and dulcite and fails to ferment saccharose, raffinose, starch and inulin.

These groups agree almost perfectly with two groups which may be formed from the low-ratio cultures isolated from milk. Special methods failed to give evidence, with the exception of the single culture mentioned, of the presence in bovine feces of the high ratio group which made up about one half of the milk collection.

Studies on the Classification of the Colon Group: I. J. KLIGLER.

Eighty organisms generally classed under the colon group were subjected to a series of fermentative and other tests with a view of determining their natural grouping as based on biometric principles. The following tests were employed: (1) Morphology, Gram. (2) Fermentation of dextrose, lactose, saccharose, raffinose, glycerine, mannite, dulcite, salicin and inulin. (3) Coagulation of milk. (4) Liquefaction of gelatin. (5) Production of indol. (6) Reduction of nitrates. (7) V. & P. reaction. Fifty-seven of the strains fell into the lactose fermenting division; twenty did not ferment lactose but fermented dextrose; three failed to ferment.

Acid production as determined by titrating aliquot portions of the broth with phenolphthalein as an indicator was found to be a more constant and a more reliable differential test than gas production, as ordinarily determined. The degree of initial acidity had no appreciable effect on the final acidity, which was quite constant, reaching its maximum on about the fourth day. The fifty-seven lactose fermenters attacked mannite, glycerine, saccharose, salicin raffinose, dulcite and inulin in the order named. Mannite, raffinose and inulin were found to be of minor or doubtful classificatory importance. Saccharose divides the lactose group into two distinct subgroups.

On subdividing the saccharose groups on the basis of dulcite and salicin fermentation respectively, it was found that the saccharose-salicin groups gave better correlations with indol production, V. & P. reaction and gelatin liquefaction, than did the saccharose-dulcite groups.

The saccharose positive, salicin positive group corresponds to *B. aerogenes.*

The saccharose positive, salicin negative group corresponds to *B. communior*.

The saccharose negative salicin positive group corresponds to *B. communis*.

The saccharose negative salicin negative group corresponds to *B. acidi-lactici*.

Glycerine was found to be of value in separating the cloacæ forms from the aerogenes bacilli, 78 per cent. of the saccharose positive, salicin positive, glycerine negative strains being liquefiers.

It must be kept in mind, of course, that this classification was obtained with a relatively small number of organisms and can at best be considered only tentative. The results are, however, sufficiently interesting to merit further investigation, especially on the part of those interested in the bacteriology of water. Of the dextrose positive lactose negative forms five liquefied gelatine and fermented dextrose and saccharose but failed to ferment any of the other sugars, with the exception of glycerine, which was fermented by two of the organisms. Of the other tests, all were negative with the exception of indol, which was negative for the two glycerine positive organisms and positive for the glycerine negative. For the present all the five may be grouped under the name *B. vulgaris*. The sixty-two members of the colon group discussed may, therefore, be said to fall into six main species as follows:

Species	Specific Texts	No. of Organisms
B. communior	dex. +, lac. +, sac, +, sal. —,	12.
B. communis	..dex. +, lac. +, sac, —, sal. +,	11.
B. aerogenes	..dex. +, lac. +, sac, +, sal. +,	19.
B. acidi lactici	..dex. +, lac. +, sac, —, sal. —,	6.
B. cloacæ	....dex. +, lac. +, sac, +, sal. +, glyc. —,	9.
B. vulgaris	...dex. +, lac. —, sac, +, gel. +,	5.

A Biochemical Study of Proteins with Reference to the Behavior of Bacteria towards Pure Animal and Vegetable Proteins: Joel A. Sperry, 2d.

Solutions of unchanged egg albumin, serum albumin and edestin were carefully prepared. To these solutions sodium chloride, sodium sulphate, calcium chloride and potassium phosphate were added. The composition of these solutions was then of such a character that the bacteria were obliged to break down the protein molecule in order to obtain the necessary nitrogen to synthesize their food in the presence of the inorganic salts. The two most important factors in this investigation are: first, that the protein used is really a normal or unchanged protein, and second, that there must be nothing in the final solution from which the organism might obtain the necessary nitrogen, except the native protein. The organisms used in this investigation were *B. subtilis*, *B. prodigiosus*, *B. anthracis*, *B. proteus vulgaris* (two different strains), *B. proteus mirabilis*, *B. coli*, *B. typhi*, *B. pyocyaneus*, *Bacillus "Z,"* a proteus-like organism isolated from the feces of white rats fed on experimental protein diets, and the anaerobes, *B. putrificus*, *B. anthracis symptomatici*, and *B. edematis maligni*.

Test tubes containing about 10 c.c. of the protein solutions were inoculated from 24-hour slant agar cultures. In making the inoculations every precaution was observed to avoid transferring any of the medium to the tubes containing the protein solutions. Plates were poured immediately after inoculation, and at intervals of 24, 48, 96 hours, and one week; in a few instances ten days and two weeks. The amount of the inoculated material used in the plates was 0.5 c.c. of a 1:10,000 dilution. The plates were incubated at suitable temperatures and the number of colonies counted 24 to 48 hours later. The period of time during which the organisms survived after being planted in the protein solutions, as shown by the examination of the plates, varied from 48 hours to 10 days. None of the inoculated material gave any visible evidence of decomposition or even putrefaction. Flasks containing 25 c.c. of the different protein solutions were inoculated with various organisms and incubated at the optimum temperature for the organism under observation, for a period of two weeks. At the end of this time tests were made to determine the quantity of coagulable protein. The amount of coagulable protein in the inoculated flasks and the control flasks remained the same, showing clearly that there was no appreciable loss of protein.

A Study of the Bacteria Concerned in the Production of the Characteristic Flavor in Cheese of the Cheddar Type: Alice C. Evans and E. G. Hastings.

A comparative study of the flora of raw- and pasteurized-milk cheese of the Cheddar type has been made, with reference, particularly, to the production of characteristic flavors. The raw-milk cheese flora was found to consist of the following four groups of cheese organisms: *Bact. lactis acidi*, *Bact. casei*, Streptococci and Micrococci. Several varieties of each group occur in

the cheese, according to the classification as determined by the fermentation in broth containing carbohydrates or related substances. The flora of pasteurized-milk cheese is shown to depend upon the organisms introduced in the starter, with the exception of the *Bact. casei* group, which develops slowly and is concerned with the production of the biting flavor in mature cheese.

Many experimental pasteurized-milk cheeses were made with starters consisting of the organisms isolated from normal raw-milk cheese, either in pure culture or in varying combinations. The results of these experiments showed that pronounced differences in the flavor could be brought about by varying the cultures in the starter. Certain combinations in the starter resulted in an improvement of the flavor.

Technic

The Application of Practical Records to the Maintenance of Stock Bacterial Cultures: L. T. CLARK AND W. L. DODD. (By invitation.)

The scope of a bacterial culture bureau has been gradually broadened, as new organisms have been isolated requiring additional tests to differentiate between old and new species. To assist in their classification a practical system of records is a necessity and to this end the writers submit a method which has had three years' application. Essentially it consists of a double system of records: one, a card index, consisting of classification charts which provide for the morphological, cultural and biochemical characteristics as well as space for the name, age, source and number of the organisms in question. The auxiliary system is a book record of the cultures in numerical rotation.

To avoid confusion resulting from maintaining cultures on the shelves in numerical sequence, an arrangement in groups according to biochemical, morphological and cultural characteristics has been found convenient. Protection from light and dust is provided by means of the black boxes described by Novy. The variable requirements of organisms make it necessary to transplant them at intervals ranging from three weeks to a week or less. Growth of stock anaerobes is established in a volume of pure hydrogen gas. Most pathogenic types may be grown for the first twenty-four hours at incubator temperature, after which they are easily maintained at ordinary room temperature. Saprophytic cultures are kept continuously at room temperature. A duplicate set of cultures is maintained at a low temperature.

The following advantages may be claimed for the system as outlined: The history of the culture forms a part of the record and is readily available; the cultures are easily handled and transplanted; any one of the organisms may be easily and quickly located by its number, name or by some predominant biologic characteristic.

The arrangement in groups, of cultures of similar characteristics, facilitates a further and more complete classification. This leads to the detection of variations between strains of the same species.

A Study of the "Tellurite Reaction" with the Colon-typhoid Group and other Organisms: LEWIS DAVIS.

The writer has investigated the reaction of potassium tellurite with the more important members of the colon-typhoid group and allied organisms, with the view of determining:

(*a*) Differences in antiseptic action on the various members of the group; (*b*) variations in the macroscopical appearance, character and velocity of the "tellurite reaction" under optimum conditions; (*c*) the influence of treatment with tellurite on the biochemical activities of the organism.

The bacteria studied included the following, arranged in the order of their resistance to the antiseptic action of potassium tellurite: *B. capsulatus mucosus*, *B. capsulatus*, *B. coli communis*, *Bact. (lactis) aerogenes*, *B. cloacæ*, *B. proteus vulgaris*, *B. paratyphosus "B,"* *B. of swine plague*, *B. enteritidis*, *B. typhosus*, *B. paratyphosus "A,"* *B. paracolon*, *B. acidi lactici*, *B. choleræ suis*, *B. rhinoscleromatis*, *B. pneumoniæ*, *Bact. dysenteriæ (Shiga)*, *B. icteroides*, *Bact. dysenteriæ* (Flexner) and *B. sopfii*. The variations in resistance to potassium tellurite, as well as in the appearance of their reaction with this salt, are considered sufficient to suggest the use of the tellurite for differential diagnosis within the colon-typhoid group.

The intensity of bacterial action on potassium tellurite was found to depend upon the individual resistance of the bacterium and the concentration of the salt present. The velocity of reduction of the tellurite is considered to be a specific function of an organism apart from its resistance to antiseptic action. Most of the types studied showed a reaction within thirty minutes. With the colon bacillus the reaction was almost instantaneous. Comparison was made of the action of "tellurited" and normal bacteria with dextrose, lactose and saccharose bouillons, respectively, as well

as with litmus milk. Treatment with potassium tellurite was found to have practically no influence on the biochemical reactions of an organism.

An Improved Technique for Performing the Grüber-Widal Test for Typhoid Fever: F. M. Meader, M.D.

The method herewith described is not new in its elements, but the combination is one which I have not noticed in other laboratories that I have visited or in the literature. We have been using the method in the city laboratory of Syracuse for three months now with considerable satisfaction. A description of the method is herewith offered.

Apparatus.—There are used the following materials: 1st, a vial with straight sides, 2 cm. long and having a 0.5 cm. lumen. The cork stopper has fixed into the inner surface a lance. (*A*) 2d, a standard wire loop made from a No. 25 U. S. gauge platinum wire, the lumen of which is 2 mm. in diameter. (*B*) 3d, a capillary pipette with perforated nipple, graduated in two places to deliver the equivalent of 3 and 4 standard loopfuls of serum. (*C*) 4th, a mixture tray having a dozen or more cells such as is used by artists for mixing paints. (*D*) 5th, a hanging drop slide. (*E*) 6th, cover slips. (*F*) 7th, alboline oil. 8th, sterile salt solution, 9th, a 24-hour bouillon culture of *B. typhosus.*

Procedure.—Prepare a control by placing a loopful of salt solution upon a coverslip. Then mix with it a loopful of the culture of *B. typhosus.* Place a ring of alboline oil around the depression in the cover glass. Invert the coverslip over the depression in the slide so that the center of the drop comes over the middle of the depression. Examine under the microscope to see that the culture is active and that the organisms are sufficiently numerous. If the preparation is satisfactory, the time is noted and it is set aside for one hour.

Given a sample of blood in vial *A*. If the vial is about one fourth full of blood, and is then centrifugalized, there will be a satisfactory amount of serum present. With the graduated pipette measure 4 loopfuls of salt solution into one of the cells of the mixing tray. Then measure 3 loopfuls of salt solution into another cell of the mixing tray. With the standard loop take one loopful of the serum and mix it with the salt solution first measured out. This makes the dilution of serum 1–5. Transfer a loopful of this mixture to the second solution measured out. This makes a dilution of 1–20. Transfer a loopful of this mixture to a coverslip. Add to it a loopful of the culture of *Bacillus typhosus.* This makes a dilution of 1–40. Prepare a hanging-drop slide as above with oil. Invert the coverslip over the depression and examine under microscope. Note the time and examine one hour later for agglutination.

The particular point of value in this technique is the use of the capillary pipette. Since there is a perforation in the nipple, the salt solution will rise to the graduations by capillary force, so that an exact amount of diluent can be easily and accurately obtained. The liquid can be pushed out into the cell of the diluting tray by covering the perforation with the finger and compressing the bulb. Since the viscosity of serum is greater than that of salt solution, the volume of a loopful of serum will be greater than the loopful of salt solution. So that in calibrating the pipette 3 and 4 loopfuls of serum should be used instead of salt solution in order that in practise the volumes of diluent and serum will be comparable. The method commends itself for its simplicity, rapidity of operation and precision in measurement.

A Synthetic Medium for the Determination of Colon Bacilli in Ice Cream: S. Henry Ayers and William T. Johnson, Jr.

In a study of the bacteria in ice cream we have endeavored to prepare a synthetic medium for the detection of colon bacilli. During the experiments 53 different combinations were tried. The most satisfactory medium was made as follows: Agar, 1.5 per cent.; asparagin, 0.3 per cent.; sodium dibasic phosphate, 0.1 per cent.; lactose, 1.0 per cent., and 2 per cent. of a saturated solution of litmus. The majority of the bacteria in ice cream did not grow on this medium, while colon bacilli showed quite characteristic acid colonies which with a little practise could be readily detected. The colon count on litmus lactose asparagin agar was compared with the estimated number from lactose bile tubes in 43 samples of ice cream. In 41 of the 43 samples the number determined on the plates was higher than the estimated number from the bile tubes.

Suspected colon colonies on the asparagin plates from 19 samples were picked off and inoculated into lactose broth fermentation tubes. From ten plates all the suspected colonies, or 100 per cent., proved to be gas formers. Among the other nine plates the percentages ranged from 87.17 per cent. to 98.01 per cent. This shows that it is possible to detect quite accurately any colonies of gas-forming bacteria on litmus lactose asparagin agar.

A comparison of this medium with Endo medium showed that the colon count on asparagin agar was much lower than that on the other medium. We found, however, that in some cases at least it was impossible to consider all typical colonies on Endo plates as colon bacilli. Certain strains of *B. coli* failed to give typical colonies on Endo plates and acid and peptonizing bacteria gave reactions similar to some of the colon strains.

It is evident that we have no entirely satisfactory method for the determination of colon bacilli, but it is believed that the use of synthetic media may be developed to a point where it will be superior to other methods.

A Satisfactory Platinum Needle: L. A. Rogers.

The tendency of platinum needles set in glass handles to break when they are flamed, is a source of annoyance. A needle which will avoid this trouble may be made by fusing the platinum wire into a copper wire. This may be done by twisting a bit of small wire about the platinum wire and holding in the flame of a blast lamp until it forms a ball at the end of the wire. The copper ball and the end of a copper wire of the proper size are held together in the flame until they fuse. The rough joint obtained may be hammered or filed to approximately the diameter of the copper wire, which should be large enough to insure rigidity. The wire may be mounted in a capillary tube or in an ordinary glass tube with plaster of Paris. The needle may be thoroughly flamed without danger of breaking.

FRIDAY, JANUARY 2

Immunity

On the Value of a New Skin Test for Diagnosis of Tuberculosis: Dr. J. Bronfenbrenner.

In the work reported to this society last year by Dr. Manwaring and myself[1] and subsequently continued and published in the *Journal of Experimental Medicine*,[2] it was shown that tuberculous guinea-pigs acquire the power of reducing the number of tubercle bacilli injected into their peritoneal cavity; that certain fixed cells of the peritoneal cavity were apparently responsible for this phenomenon, as even removed from the body of the guinea-pig the isolated peritoneal tissues of tuberculosis animals had the power of reducing the number of tubercle bacilli placed in contact with them; that, however, as far as our experiments went the intraperitoneal destruction of tubercle bacilli in tuberculous animals was not caused by circulating antibody. It was thought, however, worth while to investigate what changes the blood of these guinea-pigs underwent in the conditions of the experiment, as it seemed improbable that the cells of the peritoneal cavity could have acquired immune properties without these being present in the blood. A series of experiments was undertaken to test complement deviation on the blood of tuberculous animals, but the results obtained varied with the different strains of tubercle bacillus used as antigen. In general, however, experiments showed that the blood of guinea-pigs often contains specific antibody against tuberculous antigen. Having established this fact, an attempt was made to see if this antibody is of the nature of a bacteriolysin. The series of experiments were performed both in vitro and in vivo. In the course of this last series of experiments a very interesting phenomenon was noticed, namely: that if a normal guinea-pig was injected intraperitoneally with a mixture of the serum of a tuberculoue guinea-pig with the peritoneal exudate resulting from the injection of a small amount (10,000) of tuberele bacilli in the peritoneal cavity of another highly immunized guinea-pig, often a local reaction would result on the spot of inoculation, followed by a rise of temperature. This local reaction was especially pronounced in the cases where the peritoneal wall was punctured several times for the purpose of removing a sample of the exudate, and in this way probably a part of the mixture was introduced from within the peritoneal cavity under the skin of the animal. In analyzing this phenomenon it was found that the peritoneal exudate employed in these experiments could be conveniently replaced by a crude tuberculin as prepared by the Board of Health of New York, but not very well by a suspension of washed tubercle bacilli. The non-washed (possibly partly autolyzed) suspension of tubercle bacilli, especially if not freshly prepared, could also be used successfully. Since then, a number of tests were performed in which guinea-pig serum was replaced by the serum of tuberculous patients, and it was found that the reaction, although not very constant, is of a prognostic value in tuberculosis.

While the work is still in progress, the experiments performed up to date seem to show that the complement is an important factor in the phenomenon, inasmuch as heated sera failed to give this reaction, yet if activated by the addition of a complement and left at room temperature for a

[1] *Centrbl. f. Bact. Ref.*, Bd. 59, No. 12, p. 371.

[2] *Jour. of Exp. Med.*, 1913, Vol. XVIII., No. 6, p. 601.

short time, they could be reactivated. Whether the reaction is due to the liberation of an anaphilatoxin from the mixture of the serum containing the toxogenin and complement with the antigen of the tuberculin, is a question to be decided in the experiments which are to follow. At present I wish to call attention to this phenomenon as a possible method for the diagnosis of tuberculosis at least in cases where the condition is not too far advanced and where there is some of the free antibody in the circulating blood.

Subcutaneous injection 0.55 c.c. of a mixture of fresh blood of patients suffering from tuberculosis (1 c.c.) with tuberculin (crude diluted 1 to 10 0.1 c.c.) into a normal guinea-pig causes a local reaction similar in its aspect to a tuberculin reaction which is of good prognostic value in diagnosis of tuberculosis.

The Relationship of Anaphylaxis to Immunity: Fraser B. Gurd.

The experiments reported in this paper were undertaken in the hope of procuring data which might throw light upon the fact, now well established, that in order that an animal may become "immune" to a complex proteid, such as serum albumin, it is necessary that the animal first become, potentially at least, anaphylactic.

The author believes that there is not sufficient evidence upon which to base the theory of sessile and free receptors, as suggested by Friedberger and recently actively championed by Weil. That the reaction of the body to the parenteral introduction of foreign proteins is an exhibition of the property of parenteral digestion, is well established, as indicated by the work of Alberhalden, Zunz, Friedberger and others. That at one stage in the process of protein cleavage a highly poisonous split product is produced, is also proven, and that it is on account of the elaboration of ferments or lysins, capable of producing cleavage of the injected protein with the liberation of this toxic product, that the anaphylactic state is developed, appears sufficiently well supported by numerous experiments. The author desires to suggest that the immunity to or tolerance of heterologous protein introduction is due to the tissues of the repeatedly injected animal acquiring the property of elaborating a second order of lysins which are potent to produce more complete cleavage of the toxic split-protein products. Thus it is due to the presence in the body fluids and tissues of two orders of lysins, that the "immune" animal is itself protected against the harmful effects of protein injection, even though its serum is potent to passively sensitize normal animals.

The author's experiments prove that it is possible, by varying the quantity of transferred serum injected, to render normal animals either highly sensitive or "immune." Thus, two guinea-pigs which received (intravenously) .6 c.c. of serum from an immune rabbit were found to be sensitive (at the end of 24 hours), to 5 and 6 minims of sheep's serum, the latter with a fatal termination; whereas a rabbit which received 4.0 and 4.5 c.c. of the same rabbit serum on two successive days, and 24 hours later was injected with 7 minims of sheep's serum, was found to be immune.

In another series of experiments the toxic injections were carried out immediately following the injection (intravenous) of the transferred serum. In these experiments it was found that whereas 0.5 c.c. of rabbit's serum rendered a normal pig highly anaphylactic (dyspnea and convulsions), the injection of 2.75 c.c. was sufficient to induce a complete tolerance to the toxic injection of the protein.

Study of the Bacteriology of the Posterior Nasopharynx in Scarlatina: N. S. Ferry, M.D.

The study of the bacteriology of the posterior nasopharynx in scarlatina was undertaken by the writer to isolate, if possible and determine the rôle of a certain micrococcus found in this region and briefly described by Dr. Schultze in a preliminary report in the *Medical Record*, New York, December 10, 1910. This organism was seen by Dr. Schultze in smears from 459 out of 555 cultures taken from the throats of patients suffering with typical symptoms of the disease. The greatest number of positive findings have been obtained by swabbing the posterior pharyngeal wall and allowing the swab to stand in a test tube of bouillon a few hours. The entire amount of bouillon is then plated in the usual manner. The organism was not isolated in the later stages of the disease and was not found in any of the purulent discharges nor the blood, which seems very significant considering the fact that it appears to coincide with the contention of the majority of observers that the disease is contagious only in its early stages. For convenience in nomenclature this organism was called by the writer Micrococcus "S" and, for the present, it will continue to be designated by that term.

The Mic. "S" is a large coccus usually found in pairs and often tetrads which grows luxuriantly on all culture media after the first few generations. Whether the Mic. "S" has or has not any spe-

cific clinical or pathological significance, for the purpose of placing it on record, a detailed description of the organism will be given, followed by a brief review of the experimental work carried out with it.

Morphology.—Mic. "S" is a large, clearly defined, biscuit-shaped diplococcus, sometimes appearing in tetrads, measuring about the size of the meningococcus and gonococcus. It is non-spore-bearing, non-motile, non-capsulated, stains deeply with all aniline dyes and is positive to Gram.

Cultural Reactions

Agar Slant.—Abundant, smooth, grayish-white, glistening, opaque, filiform or slightly beaded raised growth, becoming somewhat viscid within a few days.

Agar Deep.—Abundant, filiform, growth usually in one plane, with a slightly spreading surface growth.

Agar Colony.—Slow-growing, round, smooth, convex, entire, coarsely granular colony.

Bouillon.—Slight growth, clear with sediment.

Potato.—Very slight, colorless growth.

Litmus Milk.—No change.

Koch's Serum.—Slight, filiform, white growth.

Loeffler's Serum.—Abundant, filiform, smooth, glistening, pinkish white growth.

Gelatin Stab.—Gradual stratiform liquefaction. In about five days a cup forms at the surface and as liquefaction increases it reaches the sides of the tube and then proceeds downwards. At the end of six weeks, the medium is liquefied about half way down.

Indol negative.

Litmus Sugars.—Glucose, maltose and saccharose gave an acid reaction; galactose, levulose and lactose, no change.

Pathogenic Powers

While extensive inoculation experiments were carried out with this organism, nothing of any special specific significance could be gleaned from the work. Whether the organism soon loses its virulence on artificial culture media, or whether it is devoid of all pathogenic properties for the animals used, is a question which was undecided. Believing, nevertheless, that this organism was found in a large enough proportion of cases to warrant further work, irrespective of the apparently negative pathogenicity, several vaccines were prepared with it which have been fairly tested out, both prophylactically and therapeutically under the supervision of Dr. Schultze in New York and Dr. Kiefer in Detroit, which work will be reported in later communications by them.

Other observers have, from time to time, noted the presence of a large diplococcus in cultures and smears from the throats of scarlatina cases, and yet no one has succeeded in proving that it has any part to play in the disease and, therefore, very little stress has been laid on the findings. The organism described by these writers is so varied in its morphology and cultural characteristics that one is inclined to one of two suppositions. Either it is extremely polymorphous, as was claimed by Class, or else they were dealing with cultures containing streptococci, which organisms may often be seen, in smears from the throat directly or from cultures, as large diplococci.

From the experience of the writer with the organism he has isolated and named Mic. "S," which tallies with the general descriptions given by Schultze, Class and others, as seen in smears it is quite essential not only to plate the cultures, but to be absolutely certain that the colonies from which the cultures are taken have no small colonies of streptococci, either deep or superficial, adjacent to or near them. This can only be ascertained by examining the field with a lens. Among the several known organisms found in the throat, from which the Mic. "S" should be differentiated, the following are the most important.

Mic. catarrhalis.
Mic. tetragenus.
Mic. pharyngis siccus.
Dip. intracellularis meningitidis.

Studies in Avian Tuberculosis: L. R. HIMMELBERGER.

Cultures of the avian tubercle bacilli were grown on sterile banana and glycerinated slants of carrots, turnips and garden beets. The different character of the growths obtained on the different media, would suggest the use of these vegetables as differentiating media. Attempts were made to infect white rats, under conditions simulating cohabitation with tuberculous chickens and guinea-pigs and rabbits by injection of pure cultures subcutaneously and intravenously (in rabbits) without success. Two calves were infected by the ingestion of mascerated tubercular organs of chickens while in one an attempt at infection by ingestion was unsuccessful. The calves were tuberculin tested previous to infection and came from a cow which had given no actions to the tuberculin test, and were fed from a herd free from tuberculosis as indicated by repeated tuberculin tests. The calves which were infected gave reactions to tuberculin prepared from the avian organisms and on autopsy lesions of tuberculosis were found. It is regrettable that we were not able to isolate this organism. The agglutination test was tried on a limited number of birds both normal and diseased. In only

one case did a normal bird (as shown by macroscopical examination at autopsy) exhibit an agglutination titre over 1:50 and this bird had been subjected to infection. All of the birds showing lesions on post-mortem examination gave a titre as high as 1:100.

JANUARY 2, 1914

Pathology

A Comparative Study of the Intestinal Flora of White Rats Kept on Experimental and on Ordinary Mixed Diets: LEO F. RETTGER AND GEORGE D. HORTON.

The investigation extended over a period of almost one year, and was carried on in connection with the pure protein nutrition experiments of Osborne and Mendel. The feces of 22 rats were examined, 17 of the rats receiving the experimental diets consisting essentially of purified animal or vegetable protein, protein-free milk, starch and lard. The remaining 5 rats received ordinary mixed food consisting of sunflower seeds, carrots, dog-bread, meat, etc.

A change in the intestinal flora became apparent very soon after the rats were transferred from the ordinary to the special diets. The flora became more simplified, very few types being found after the first three or four days, as a rule. An increase in the number of Gram-positive organisms from 35–50 per cent. to 85–100 per cent. was frequently observed. There was no appreciable difference in the results, in so far as the individual proteins were concerned, with the exception of Zein. Although they were present in the feces of the stockroom rats in relatively large numbers, two organisms which are a part of, or closely related to, the acidophilus group of bacteria, were frequently present to the exclusion of all other types, except *Bacillus bifidus* of Tissier and *B. coli*, *B. bifidus* was much more abundant in the experimental rats than in those receiving the usual diet, while the number of *B. coli* was greatly reduced. No definite relationship could be established between the bodily conditions (growth, vigor, etc.) of the rats receiving the special diets, and the intestinal flora.

Anaerobic Culture of Coccidiodes Immitis: WARD J. MACNEAL AND RICHARD M. TAYLOR, M.D.

Two strains of *Coccidioides immitis* of Rixford and Gilchrist[3] have been studied, one derived from a fatal case of generalized infection which occurred in the practise of Dr. Chas. A. Powers, of Denver, and which has been studied by Whitman,[4] and a second isolated at this laboratory[5] from a similar case which occurred in the practise of Dr. Robt. T. Morris, of New York. We observed the metamorphosis of the spherical (Coccidioidal) bodies into typical mycelial growth on agar and the inverse change of the threads back into spherical bodies in the animal body. Finally by inoculating the spherical bodies into tubes of ascitic fluid containing bits of sterile animal tissue, or better, tubes of gelatinized horse serum, and covering these with paraffin oil or incubating in an atmosphere of hydrogen, we succeeded in obtaining abundant multiplication of the spherical form *in vitro*. The forms of the organism in these cultures resemble very closely those seen in diseased tissues.

Further Observations of the Thompson-McFadden Pellagra Commission upon the Etiology of Pellagra: J. F. SILER, P. E. GARRISON AND W. J. MACNEAL.

Information concerning the age and sex, occupations, location of domicile, general dietary habits, and concerning the existence of pellagra was obtained upon about five thousand persons by a house-to-house canvass of six cotton-mill villages. A similar study was carried out in one rural district of four square miles in which several cases of pellagra had occurred. Many other communities were studied in less detail. There was no definite relation observed between the occurrence of pellagra and the use of any particular foods. New cases developed for the most part in the immediate vicinity of old cases or after close association with them. In districts completely equipped with water-carriage systems of sewage disposal, we found pellagrins who had acquired the disease before moving to these districts. Cases apparently originating in these sewered districts were extremely rare and their origin there somewhat doubtful. These observations strongly suggest that unsanitary methods of sewage disposal have an important relationship to the spread of pellagra. If these indications can be confirmed in other places, we feel that the proper correction of these conditions by the installation of water-carriage systems of sew-

[3] Rixford, Emmet, and Gilchrist, T. C., "Two Cases of Protozoon (Coccidioidal) Infection of the Skin and Other Organs," Johns Hopkins Hospital Reports, 1896, Vol. I., p. 209–290.

[4] Whitman, R. C., "A Contribution to the Botany of the Organism of Blastomycosis," *Jour. of Infectious Diseases*, July, 1913, Vol. XIII., pp. 85–95.

[5] MacNeal, W. J., and Hjelm, C. E., "Note on a Mold, *Coccidioides immitis*, Found in a Case of Generalized Infection in Man," *Jour. Amer. Med. Assoc.*, December 6, 1913, Vol. LXI., No. 23, p. 2044.

age disposal will go far toward restricting the spread of the disease. The exact mode of transmission of pellagra is still uncertain and we strongly urge the continued study of food contamination, of insects as transmitting agents and of close personal association as possible factors in its spread.

Further Studies with Reference to Spirochæta suis: WALTER E. KING, RAYMOND H. DRAKE AND G. L. HOFFMAN.

This report gives in detail the results of the study of the flora of the crypts in the ceca, intestinal ulcers and the external local lesions of a number of normal, immune and diseased hogs, with reference to the presence of *Spirochæta suis*. The study includes the examination of 234 cases by means of the dark field. Of these, positive findings have been made in 171 cases, negative findings in 63 cases. Of the latter, 38 cases were hogs immune to cholera, 2 were animals susceptible but not exposed to hog cholera, 3 with typical hog cholera but treated with toxic doses of mercuric or arsenical preparations, 16 in which the organism was found either in local lesions or in the crypts and ulcers of the intestines, and 6 cases resulting in negative control findings. In 5 hogs which were made immune to cholera, *Spirochæta suis* was found in the crypts of their ceca at intervals of from 10 days to 11 weeks after exposure.

These data, together with results already reported, warrant the tentative deduction of the following conclusions: (1) In the ulcerated areas of cecal mucosa and in the crypts, near the ileo-cecal valve, of hogs dead from cholera, is localized a constant species of spirochete, *Spirochæta suis*. Experimental evidence shows that this organism is pathogenic for swine and that it plays an important part in the production of hog cholera. (2) The crypts in the ceca of activity immunized hogs may sometimes contain *Spirochæta suis* for a variable period of time after immunization. (3) *Spirochæta suis* becomes localized in the necrotic tissue or purulent exudate of the external lesions, which are sometimes present in cases of typical hog cholera, especially of the subacute chronic types.

The Relation of Lavatory Appliances to the Spread of Intestinal Infections: B. R. RICKARDS AND L. B. CLORE.

These experiments were carried out to determine the rôle played by the chain pull and other appliances of the toilet room in transmitting from hand to hand typhoid bacilli and other organisms capable of causing intestinal disorders. The surfaces tested were rubbed with sterile cotton swabs previously moistened with sterile water. Plates made by rubbing the swabs over the surface of Endos medium in Petri dishes. The plates were incubated for 48 hours at 37° C. and inoculations into plain broth were then made from a number of each of the various kinds of colonies found, attention being centered on those cultures having a typical *Bacillus coli* appearance. The work was confined entirely to the detection of the colon group, lack of time preventing experiments being carried on for the presence of *B. ærogenes capsulatus*. The broth cultures were examined microscopically after 48 hours' incubation and transplants made into Hiss's semi-solid media. These tests were carried out on media containing, respectively, dextrose, lactose, saccharose and mannit. Typical growth on all four media was taken to mean that the organism isolated was a member of the typhoid-colon group.

In each instance swabs were taken from the front of the seat, back of the seat, door knob and from the handle of the device operating the flushing tank. From the low flush tank type, cultures were made from the metal or porcelain lever. If, of the high box type, the swab inoculation was made from the metal or porcelain handle and oftentimes from the lower parts of the chain, the object of the latter being to see if there was any attempt by the users of the closets to avoid infection by putting the hands on that part of the apparatus not commonly used. For the same reason swabs were in all cases taken from portions of the door with which the hand might come in contact in case the handle of the door was avoided.

B. coli was isolated in pure culture from swabs taken from the following locations. (1) From the seat in two different toilets of the scientific department of the manufacturing establishment. In one case tests were made at three different times and *B. coli* found each time. (2) From four different seats in the public comfort station. In no case was *B. coli* detected on the handles of pull or push levers nor on the chains, nor was this organism detected on the metal or porcelain door handles or upon the wood of the door.

While the results by experiments fail to show presence of *B. coli* on any other surfaces except on the wooden seat, we still feel that there is a possibility that the handles of flushing devices may at times serve as a means of carrying typhoid or other intestinal infection or possibly gonorrhea or syphilis from hand to hand, at short intervals and that foot or automatic levers should take their places.

The Malarial Parasites: MARY R. LAWSON, M.D.

Many of the misconceptions in regard to the morphology and biology of the malarial parasites are due to the fact that the majority of observers have believed them to be intracellular, and that each parasite grew up and completed its life cycle within a single corpuscle, the segmentation of the parasite corresponding to the final destruction of the corpuscle. The writer believes the parasites to be extracellular throughout their existence, that is, when not in migration, they attach themselves to the external surface of the red corpuscles by means of protoplasmic pseudopodia surrounding mounds of corpuscular substance, which the parasite has "squeezed up" for the purpose of attachment. This interpretation is confirmed by seeing the corpuscular mounds at the periphery of the red corpuscles encircled by the pseudopodia of the parasites.

The evidence in favor of migration is:

1. The destruction of red corpuscles is usually out of all proportion to the number of parasites present, providing one parasite destroys but one corpuscle.
2. In multiple infection of red corpuscles by several young parasites, they can not all grow up on one corpuscle, therefore they must migrate or die.
3. Stages of parasitic migration such as (*a*) Free pigmented parasites, compact, amœboid, with pseudopodia. (*b*) Pigmented parasites attached to apparently healthy corpuscles. (*c*) Pigmented parasites (24 hr.) apparently in the act of abandoning degenerated corpuscles. (*d*) Parasites on corpuscular skeletons. (*c*) Corpuscular skeletons which are expanded remnants of red corpuscles which have been dehemoglobinized.

The sexual cycle takes place in the blood of man in the various malarial infections. The flagella are always derived from the chromatin substance, and from the chromatin alone. In the æstivo-autumnal infections the writer has observed but one flagellum to each crescent, while in the tertian and quartan infections, there are several flagella to each parasite.

A Preliminary Communication on the Etiology of Pyæmic Arthritis in Foals: FRANK W. SCHOFIELD.

The author after a brief discussion relative to modes of infections points out that intrauterine infection of foal can alone account for some cases, and most probably does for more than is generally believed. The bacteriology of the disease is reviewed and author's findings given. An organism of the colon typhoid group has been recovered uncontaminated from blood and joints in early stages of disease. The relationship of this organism to the disease was established by complement fixation tests using foals' blood and organism isolated as antigen. Positive fixation tests were also obtained from the blood of dams that have delivered foals which subsequently became diseased.

Experiments Bearing on Pulmonary Infection: FRANK W. SCHOFIELD.

Mention is made of two existing views regarding pulmonary infection. That it is due to direct inhalation of course into smaller air passages, or arises as the result of a primary infection of blood stream. The difficulty of infecting the lung by direct inhalation was demonstrated by experiments of following nature.

First Experiment.—Horses were exposed to a very fine spray from powder atomizer, the material used being equal parts gentian violet and powdered charcoal. After a few minutes' spraying the atmosphere became saturated with this fine violet powder. Horses breathing normally filtered all the powder out of the inspired air before same reached trachea. When excessive, labored and rapid breathing was induced the powder could be detected in the larger bronchi.

Second Series of Experiments.—A spray of *B. prodigiosus* was here substituted for the powder. The spray was manipulated so that the fine terminal portion of the same enveloped the nostrils of animals breathing it. The spray was kept up for several minutes. In most cases the organism could not be recovered past the larynx. When present in the trachea bacilli were few in numbers. The last experiment consisted of taking a number of swabs from the trachea of normal horses, cattle, sheep. In most cases the tracheæ were found to be sterile. When the organ was infected the organisms were *S. aureus*, *S. albus* and *Streptococci*. None of the common organisms present in the air these animals were breathing were recovered from the trachea.

Conclusions.—In health the trachea if not sterile has no constant bacterial flora. This could not be so if dust with bacteria could easily pass the nasopharynx.

That with nasal breathing most of the bacteria inhaled are removed before the air enters the trachea, even when the atmosphere is saturated with bacteria.

That direct infection of lung through nasal inspiration is almost impossible, under ordinary conditions.

A. PARKER HITCHENS,
Secretary

SCIENCE

FRIDAY, JUNE 5, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

IDEALS RELATING TO SCIENTIFIC RESEARCH[1]

ONE object of this society, according to its constitution, is to establish "fraternal relations among investigators in the scientific centers." These relations imply changes in ideals as the body of the investigators grows and as its members take higher and higher views as regards social obligations. Our rapid scientific development in recent years may be compared with the great strides in our financial development. It has frequently been necessary during this period to enact laws with a view towards higher financial ideals and more just financial relations. Practises which appeared tolerable when indulged in on a small scale became intolerable when their influences began to extend to wider circles.

Hence it seems natural to inquire whether our rapid scientific development has not been attended by practises which appear more and more objectionable. It is also of some interest to look into the future with a view to learning whether some of our scholarly practises, which do not meet with open disapproval at present, are likely to become intolerable when our scientific life has become much more vigorous and when our universities have become much larger and more influential. At any rate, the investigator likes to look at facts from a variety of different angles, and he realizes the need of considering also surrounding atmospheric conditions.

Ideal research is free search. On the other hand, fraternal relations imply fraternal obligations. The great army of in-

[1] Read before the Illinois chapter of the Society of the Sigma Xi, May 20, 1914.

vestigators is composed mainly of generals. Only a few are willing to serve in any other capacity after announcing by means of a doctor's degree or by some scientific publication that they have learned to walk alone. It is true that many of them were supported by the kindly hand of their teacher during this first walking exhibition and some of these never learn to walk alone; but, nevertheless, they too often want to be generals or nothing in the army of the investigators.

The difficulty of learning to walk alone as an investigator seems to vary very much with the different sciences. In mathematics, for instance, the man who has just reached his doctor's degree in an American or in a German university can not be expected to have completely acquired this art,[2] while some of the newer sciences seem to present the strange phenomenon of babies born with walking capabilities. These wide differences may be expected to diminish with the more extensive scientific developments and with the growth of fraternal relations between investigators.

The question arises whether the independence of the separate investigators is an ideal condition and whether this condition should be maintained in view of the rapid increase of the number of investigators. Our scientific army seems to have adopted Indian war tactics to the extent that each man is selecting his own tree and is firing at the cohorts of ignorance from his sheltered position. In a new and undeveloped country this may be proper and may lead to the best results, but it is at least conceivable that as time goes on the army of scientists has to be reorganized along different lines in order to secure the most effective work. The Committee of One Hundred on Scientific Research recently appointed by the American Association for the Advancement of Science may be a step towards such a general reorganization.

[2] *Cf.* M. Bôcher, Science, Vol. 38 (1913), p. 546.

In some of the sciences special reorganization has already been started. By way of illustration we need only to refer to the recent work of the Astronomische Gesellschaft, which, by international cooperation, secured accurate observations of the positions of one hundred and sixty-six thousand stars. Such organizations tend to limit, along certain lines, the independence of the investigator, and hence they affect our ideals, at least as regards some investigators. It remains, however, still true that ideal conditions for an investigator involve a large measure of freedom, just as the most effective higher teaching implies opportunities to digress from beaten paths.

Probably most of the effective scientific investigation is a result of the fact that some student has taken the time to digress from the beaten paths at various points, and finally he came into regions of unexpected fertility. Love of knowledge, not love of renown, is the ideal incentive for investigation. The ideal investigator is not the man who says to himself "I am going to become an investigator" but rather the man who becomes deeply interested in a subject and is unable to find in the literature the things he is anxious to know. He is thus forced by a desire for more knowledge to become an investigator.

In some subjects there is a type of investigators who have been forced by a kind of laziness to become investigators. I refer here to the student who finds it easier to sit and think than to get up and consult the literature. In fact, some people have gotten into the thinking habit so thoroughly that it appears generally easier for them to think than to do even as much manual labor as to pick up a book and read. Investigators of this type have sometimes developed into comparatively ignorant men with great reputations, and some of them have done very much to advance knowledge.

It does not appear likely that this class of investigators will occupy a prominent place in the future. It is only about 150 years ago that Frederick the Great asked Lambert, as a new member of the Berlin Academy, what science he understood especially well, and he received the reply "all of them." Frederick the Great then asked how he secured all this knowledge, and Lambert answered "by myself like the noted Pascal."[3] While these answers could scarcely be justified at the time of the founding of the Berlin academy, they would be much less appropriate in our day, and there is an ever-increasing need of using the results of others in research. Fortunately the means of arriving at these results are also improving. While the investigator becomes continually more dependent upon others he has the advantage of securing, by means of known results, a much wider freedom as regards fruitful subjects exposed to investigation.

In recent years the term graft has received a large amount of public attention. This is probably partly due to a rapid change in our ideals as regards political and financial standards. Our ideals as regards scholarly standards are also changing very rapidly, and it appears natural to inquire whether the term *scholarly graft* is not destined to receive more public attention unless some of our university practises are changed.

The fact that scholarly practises frequently improve with more light has been emphasized recently by results from the publications of the Carnegie Foundation for the Advancement of Teaching, as well as from the publication of a classification of educational institutions on the part of the U. S. Bureau of Education. Many other similar efforts have recently been made. One of the most important of these, as far as scientific subjects are concerned, is the work entitled "American Men of Science." It is a hopeful sign that such works have become possible. Naturally some institutions, as well as some men, have not welcomed this type of light, and slight injustices could scarcely have been avoided.

[3] *Jahresbericht der deutschen Mathematiker-Vereinigung*, Vol. 23 (1914), p. 1.

The history of the system of the honorarium in European universities furnishes many instances of injustice, and emphasizes the fact that even in good universities there is danger as regards the development of graft. The German universities have been very conservative as regards changes along this line, but in 1897 it was decided that one half of the honorarium over 3,000 Marks (in Berlin over 4,500 Marks), should, in general, be paid into the state treasury. In April, 1909, it was decided that the professors outside of Berlin were to receive, as before, all of the honorarium up to 3,000 Marks; but, if the total honorarium exceeded this amount, 75 per cent. of the sum between 3,000 Marks and 4,000 Marks, and only half of that beyond 4,000 Marks, was to be paid to the professors.

Two of the most serious charges against the practise of paying all of the honorarium to the professors were that it tended to influence some of the most noted men to give the most elementary lectures in the popular subjects, and that some professors who happened to be on the commission of examiners were tempted to make it very uncomfortable for the students who had not taken the courses offered by these professors. At any rate the system led to very great inequalities in the incomes of different professors and it was the source of many suspicions on the part of students and others.

Our American universities have thus far been comparatively free from gross scholarly graft, but it seems desirable to look at ourselves at times in a critical spirit in order to check tendencies which might

otherwise develop into gross irregularities. High ideals as regards public actions are not likely to prevail in a society where the discussion of public practises is in disfavor, since fear of exposure is one of the most useful instruments to regulate public practises.

One of the most common university practises which is at least closely related to graft is inefficient teaching. Too many of us neglect our obligations to our students. These obligations include a vigorous scholarly development on the part of the teacher. In the cases where an instructor gives graduate courses these obligations also include a vigorous growth in research ability, but they are not confined to such development and growth. This is, however, the side to which we shall pay most attention on this occasion.

Probably one reason why many of us do not consider more seriously our obligations to our students is based on the fact that there has been a rapid improvement during recent years as regards the teaching duties of the American university instructor. Too many of us have not learnt to use our freedom as rapidly as it has come to us. When an instructor has been oppressed with fifteen or twenty hours of instruction per week, in addition to directing graduate work, and finds this yoke of oppression gradually lifted, he does not always assume promptly the new obligations which this freedom implies.

It is, however, important for the younger members of our profession, and especially for those who are just now entering our ranks, to realize that holding a university position unworthily is a kind of scholarly graft which might perhaps be known as the incompetency graft. It seems very likely that with the improvement of conditions there will come higher ideals, and that in the future a higher degree of efficiency will be demanded than could reasonably have been demanded in the past.

A kind of scholarly graft which is still too common is connected with the assignment of subjects for graduate theses. Some instructors, on meeting a problem which involves an unusual amount of drudgery, seem to regard it as legitimate to lay such a problem aside until they can find a student who will take it as a thesis subject. There is no surer way to kill all research ambition on the part of the student, nor is there a surer way to secure his permanent disrespect for the teacher and the subject.

It is simply another expression of the ignoble spirit which leads some men to regard the young and helpless as their legitimate prey. The teacher who does not do his best to find attractive and far reaching theses subjects for his graduate students is certainly not ideally qualified for a position in the graduate school. The use of graduate students to promote the interest of the teacher is simply a type of scholarly graft which we may call the promoter graft. Moreover, it is one of the most despicable types in existence in view of the fact that it affects those who have not yet formed strong scholarly habits.

The promoter graft presents itself in many other forms. One of the most common of these is an undue emphasis on the work done by the teacher himself. What is still more pernicious is to offer courses mainly with a view to learning a subject or with a view to writing a paper on a particular subject. It is difficult to prescribe proper limits along these lines. Research enthusiasm can generally be conveyed to students most effectively by the man who is himself profoundly interested in his subject, and who knows exactly how far the subject has been developed. Work along the border line between the known and the unknown has the greatest fascination, espe-

cially for the young man who never before experienced the joy of knowing beautiful and general results which have never been published.

It is, however, essential that these new results should be both beautiful and general in comparison with the many elegant things which have been found out by others. The great danger is that an instructor will find mainly non-interesting and trivial results in comparison with the many important known results which his students have not yet mastered. In view of the great differences in research capacities of university professors it is very difficult to give limits as regards the amount of original work which may properly be incorporated into our graduate courses.

All of us could doubtless point to clear instances where students have suffered greatly on account of injustice along this line. The extreme cases of the promoter graft are almost as vicious as the extreme cases of the incompetency graft. In many instances the former are the more difficult to correct since a large amount of the knowledge in the subject concerned is essential for judging the merits of such a question. Moreover, in view of the comparative infrequency of these cases the public has not yet been educated to denounce them with sufficient severity.

In recent years there has been a rapid increase in the number of scholarships and fellowships in our American universities. About twenty years ago G. Stanley Hall published, in Volume 17 of the *Forum*, an article in which he gave a list of the scholarships and fellowships which were then available for graduate work in our universities. By comparing this list with those which are now available, we shall note a remarkable change.

Those who are always looking for some kind of graft have found a fruitful field of operation in these scholarships and fellowships. It has not been uncommon for a professor to appropriate a large part of the time of the students who were picked with a special view to their promise to develop into research men, and who needed all their time for their scholarly development. Fortunately these plunders are becoming less common and our attitude towards scholarships and fellowships is improving. In some universities it is almost ideal.

These scholarships and fellowships have, however, some unfortunate features since they frequently attract young people to institutions and to departments which can offer very few other attractions for the graduate student. The student who is thinking of doing research work can not be warned too strongly in reference to the scholarship and fellowship traps set by various institutions which are poorly equipped for graduate work. Fortunately, many of the best equipped institutions also offer such inducements, and the most capable and most cautious students are not apt to suffer. On the contrary, such students frequently derive a great amount of good from the assistance thus received.

There is no doubt about the fact that a graduate student who comes to a university under the influence of financial assistance from the university is often inclined to consider the channels of this influence. Hence he will generally not feel quite as free, as the one who is not thus encumbered, to act independently as regards his courses or the sources where he seeks information about them. This tends to increase administrative influence at the expense of the influence of scholarship, and often leads to what deserves the name of administrative graft.

While graduate scholarships and fellowships may tend somewhat toward graft, it is not implied that they offer a very serious problem along this line. They merely call

for precaution and proper warning. The average graduate student who holds a scholarship or fellowship needs greater encouragement to become independent and to develop high scholarly ideals. The atmosphere should not create the feeling that further assistance is likely to depend on whether he takes a course with the head of the department or with some other member of the department who may have unusual administrative influence.

A large university makes many demands on the faculty for committee work and for other incidental services. It often happens that some professors fail to do their just share of such work. In the cases where this work appears useless they are to be commended for expressing in this way their disapproval. On the other hand, there is much very useful and necessary work outside of the class room, and those who are unwilling to do their full share of such work belong to a class of grafters who might appropriately be called shirking grafters.

All tendencies towards scholarly graft which have been considered thus far are generally represented in an ordinary faculty. Probably most of us have excellent illustrative examples in mind even if we fail to see where we might ourselves contribute to the list of illustrations. It may, however, be more agreeable to proceed to consider a type of graft which relates to the future American university which has at least twenty thousand students. We shall thus have the advantage of a university faculty whose members we may praise or censure with perfect freedom.

I desire to call your attention to the serious text-book graft in this future American university. Whenever a new administrative head[4] of a large department is elected he is practically beseiged by the agents of publishers of text-books. These publishers want him to write text-books for the thousands of students in his department. They care little about the merits of the books. The fact that these books will be used in this university for several years, at least, and that they can be sold at a high price is a sufficient guarantee to publishers.

Moreover, it might happen that such a man would actualy write as good books as those placed on the market by other publishers. In this case there would be a fair chance that by judicious advertising the sale of the text-books, written by our new administrative head, might become extensive, and this would mean so much more profit for the publisher.

Administrative heads of departments in our large future universities have an additional advantage in the fact that publishers will not assume the risk of publishing college text-books unless they are written or edited by such administrative heads. The smaller institutions are thus practically compelled to use the text-books written by the men in the larger universities and this reduces competition.

There are other very serious elements in this situation. Ostensibly these text-books are written on the supposition that they meet local needs better than any of those already on the market. There are fifty men in the department who have to teach the books written by the administrative head and all of these fifty men agree that these books meet local needs admirably. That is, they are perfectly agreed on this point as long as there is no change in the administrative head. If, perchance, one would hold a different view, his influence in the

[4] Heads of departments are determined by the scholars in the field represented by the department. It seems as foolish for the administrators of the university to appoint heads of the departments as it would be for state legislatures to fix by law the value of π. Administrative heads can, of course, be appointed by the administrators of the university.

department would soon reveal his error and thereafter he could also see the situation in the true light.

In the small colleges a teacher will be inclined to call the attention of his students to points of view which appear to be an improvement over those set forth in the text. In fact, they will often call attention to other text-books in which special subjects are treated in a more satisfactory way. In the future large universities under consideration there are no temptations to indulge in any speculations which would imply that the text-book could be improved except perhaps as regards typographical errors or mistakes in the answers.

The fifty teachers using the same book are not tempted to waste their time and energy by comparing other text-books with the one in use. They are not tempted to discuss with each other in a free way such trivial questions as those involved in a study of the order in which various parts of the subject should be treated. All of these questions have been settled for them by the text-books which they are practically compelled to use and they have plenty of time for thoughts along other lines.

One of the main advantages of this situation still remains to be mentioned. The students are highly impressed by the fact that local men are wise enough to write such books as they are using. They actually have seen once or twice the authors of their text-books, and the university which has such men on its faculty secures thereby a strong claim for eminence and useful service. This fact naturally appeals to the university administration and helps to block the way towards reform.

Finally, a hopeful element appears in this situation. Some crank begins to call attention to the fact that injustice is being done. Being a crank he keeps on enumerating such things as follows: Is it reasonable to suppose that an elementary text-book written by the administrative head of a department including fifty teachers should meet the views of these teachers as well as one selected by them from all the others on the market? Would it not be well to exclude by law text-books written by local men in those cases where a considerable number of different men are expected to teach classes by means of the same text-book?

Statements like these, and conditions enumerated above, naturally appeal to people whose sensitiveness to questions of graft has been greatly increased through decades of newspaper agitation, and our crank has an easier task than one might have supposed. He receives newspaper support, and legislative support follows. Laws are enacted which restore the freedom of discussion of text-books even in these large future universities. In view of the fact that these laws are enforced, this text-book graft becomes a thing of the past. As a result, the really meritorious college text-book lives longer and is consequently sold to the student at a more reasonable price.

Whether this glimpse into the future university is justified by the present trend can not be considered here. Our aim was to call attention to the dangers whose seriousness naturally appeals to us in different degrees. It is scarcely necessary to add that these dangers are national in scope. Whatever view we may have of them it seems clear that we should consider their bearings as behooves those engaged in research.

Text-book writing is sometimes attended at present by a feature which appeared to be too unjust to attribute to our future large university. It has often happened in large undergraduate classes that mimeographed notes which could scarcely be deciphered by the students were substituted

for an excellent text-book while a mediocre text-book was being written. Such procedures call for the strongest condemnation, especially since those who are being abused in this way are not in position to defend themselves properly.

Having exhibited a few tendencies towards scholarly graft the question arises whether a study of such matters is likely to promote scientific research. As a matter of fact an affirmative answer to this question is necessary to justify the preceding remarks on an occasion of this kind. Scientific research is based on a profound conviction that truth is desirable, and such research seems to thrive best in an atmosphere where all truths are welcome and where all honest efforts to arrive at the truth are respected.

This society is based, in part, upon the theory that there are wide differences as regards scholarly achievements among the faculty as well as among the students. It calls for observations as regards scientific achievements and for a public expression of conclusions relating to such achievements. These things are intimately connected with the questions considered above and hence these questions seemed appropriate even if they affect only indirectly our main interests.

In financial circles there seems to be a tendency to welcome the most searching scrutiny on the part of the public. Our scholarly methods should be freely open to the same kind of scrutiny. Practises which suffer thereby would be apt to become worse and to suffer more severely through a later investigation. It seems also very desirable that we should institute such investigations from within before they are suggested by a dissatisfied public.

There is a general impression that scholars are too poorly paid and that we should not interfere with the efforts which some of them are making to increase their incomes. On the other hand, the fact that a rule of the University of Paris provides that no professor shall be able to increase his salary beyond twenty thousand francs by accepting numerous teaching positions, shows that in a leading intellectual center it has appeared desirable to limit the professor whose financial ambitions interfere with what appear to be the highest university interests.

In view of the fact that there is such a large army of men engaged in scientific investigation it is reasonable to expect to find in our own ranks a great variety of types of mind. Many of us doubtless believe that some subjects which have found a place in respectable society as regards subjects of learning are practically graft-subjects. Subjects where the brilliant advances of one generation dwindle repeatedly into nothing through the scrutiny of the following generation, must convey a strong odor of graft to a scientific mind. This is true in spite of the fact that these subjects frequently relate to things about which we would all sincerely wish to have more light.

One object of a university course should be to lead the mind of the young towards useful channels of thought and to warn them against those subjects whose main capital is wasting the time of the student by discussing things about which we know nothing; or, what is still worse, by cultivating the dishonest state of mind which delights in pretentions of knowledge where there is no knowledge. The greatest foe of knowledge is the pretended knowledge which can not now be disproved, and the greatest danger which besets the students who are seekers of truth is the net of glittering but baseless generalities which are sometimes spun out before their eyes under the name of undergraduate university instruction.

Fortunately our own society is dealing with subjects where progress is permanent and where sham progress finds little room. It is true that these subjects reach into those of a different type and that Barnums and Ringling Brothers sometimes arise in our midst, but they do not represent the normal phase of our subject. We are living in houses built of strong material and hence we should not be afraid to throw stones at all appearances of graft. Our progress in the past has been largely due to an honest admission of unknown elements in our subjects. We have represented these by symbols and thus developed an algebra, which has led to marvelous advances.

This algebra of science naturally does not appeal to those whose mental caliber is such that they can enjoy only fiction, but it is this algebra which has made possible many of the conveniences of our fiction readers. It is an interesting sight when men use the telephone and the electric railway to call and to attend meetings for the purpose of belittling the value of science. These things are, however, becoming more rare, and one of the important duties of the scientific investigators is to maintain high ideals within their own ranks. These permeate the atmosphere which surrounds their work, and a favorable atmosphere is one of the essentials for vigorous scientific development.

Another important reason for maintaining the highest ideals among investigators is based upon the fact that the career of the investigator offers many excellent openings for the crook, and this constitutes one of the most alarming features as regards the permanent dignity of our profession. In fact, few other lines of work can offer more opportunities to those inclined to indulge in unfair practises. We all agree that some of the most important investigations require long periods of years, and that the investigator who has proven his ability should not be required to give an accurate account of how he is spending his time.

What a splendid opportunity these conditions afford to the crook. He too likes to be free from giving an accurate account of himself, and if he can deceive his superiors for a period of years by creating the impression that he will soon do something that is very important, he may have arrived at a position of independence before the truth becomes known. That such things are happening around us, few would probably be inclined to deny. When the lot of the investigator was a much harder one there were few temptations for the crook in this field, but with the improvement of conditions these temptations increase, and those who desire to be honest can not welcome too heartily the most searching investigation as regards our outward research practises.

There seems to be a growing respect for scientific investigations, and it is our duty to maintain this respect. With the increase of funds devoted to investigation, there naturally goes a growing interest in investigators and consequently a growing scrutiny of their practises. As these funds come more largely from the masses we are becoming more subject to waves of popular opinion. History furnishes many instances of how these waves may become agitated by disclosures of irregular practises. Hence a deep loyalty to the highest interests of scientific investigation carries with it a deep interest in the improving ideals of the investigators.

Unless these ideals are kept relatively high and a large number of useful discoveries continue to result from investigations, there seems no good reason to assume that scientific investigation can permanently maintain its position. The vicissitudes of

scholars in past ages serve to remind us of sad possibilities, and they should serve to spur us to the noblest efforts. The greatest danger which besets investigation is corruption within the ranks of the investigators. It still remains to be proven that the lot of the investigators in pure science can be made permanently attractive without supplementing them by crooks.

We all rejoice in every new evidence of the benefits derived from scientific discoveries. Those which reach every corner of our land are especially fraught with significance in view of their widespread effect in inspiring general confidence in the value of scientific investigation. Hence we have good reason to rejoice at this time on account of the important rôle scientific sanitation played in the digging of the Panama Canal. Such evidences have been so numerous in recent years as to create a new danger: viz., the unthinking mass may become too easy a prey to the extortioner who may use these facts to secure an undue amount of money from them. Oppression even in the name of promotion of science can not be countenanced by those interested in the permanent service of our subject.

In closing, I desire to call your attention to the fact that one of your serious duties is to make people forget that you were elected as members of the Sigma Xi, just as people ought to forget that you are a graduate of a college or that you have the doctor's degree. If, when you think of a man who is over forty years old, the thing that is prominent in your mind is that he graduated from Harvard or that he took his doctor's degree at Paris, it is almost certain that the man does not amount to much. If our future attainments do not overshadow our local university distinctions we have not been a success.

Your entrance into this society should overshadow the honors achieved through your good work in the high school; but compared with your future achievements, these present honors should sink into insignificance. A few years ago we thought of President Wilson as the president of Princeton, but to-day we think of him as president of the United States. Those of us who think of both of these types of positions as political achievements will naturally think of the latter achievement first. As far as the former position implies scholarly achievements, it can, of course, not be compared with the latter.

In purely scholarly achievements the comparison is simpler, and, in this case, we should always view with suspicion the man of forty who is still regarded as a Harvard or a Yale product; or who is still distinguished by the fact that he has a Ph.D. from a noted institution. I can not help thinking of such a man scientifically as still a babe in long dresses. Desirable as these distinctions may be in early years, they are only of temporary prominence as regards the man who actually is worthy of them. To avoid misunderstanding, I desire to emphasize the fact that I believe very heartily in such scientific distinctions as those which are attached to your election to this body. I sometimes think we have too few opportunities to mark in a public way, the various steps towards higher and higher scientific attainments. The fact which I desired to make perfectly clear is that our eyes should always be fixed on still higher attainments. There are too many intellectually satisfied people among us—too many whose scientific achievements could no longer be verified if they had not been securely established on parchment with India ink.

We welcome you into a society which stands for infinite progress in fields of infinite riches, a society which recognizes that our fathers knew less than we do and that

our children will know more than we know, a society which aims to establish fraternal relations among its members and which recognizes that hearty and continued co-operation is essential if we would succeed in securing those rich rewards of mind and body which past scientific discoveries lead us to expect to find in the unexplored regions.

G. A. MILLER

THE FOUNDATION OF THE GEOLOGICAL SOCIETY OF AMERICA[1]

THERE was an "American Geological Society" in 1832 at New Haven, Conn., but it faded out in the glare of the chemical and physical sciences which bloomed brilliantly at that time in New Haven. I have not been able to get any detailed information concerning it.

About the same time was organized the Geological Society of Pennsylvania, 1832. At a meeting of February 22, 1832, the officers were John R. Gibson, president, Nicholas Biddle, vice-president; Stephen S. Long, vice-president; Henry S. Tamer, treasurer; Peter A. Browne, corresponding secretary; George Fox, recording secretary.

This society sent out a circular signed by John Gibson and George Fox announcing the organization and asking assistance in getting information and specimens. The organ of publication was Featherstonhough's *Monthly American Journal of Geology*.

This society seems to have aimed to develop the geology of Pennsylvania specially, but its plan of operation covered other states. It came quickly into competition with the Philadelphia Academy of Science. Its transactions were published in Featherstonhough's *Journal*, at first, but as that *Journal* passed through only one volume, it is unknown to me whether the society survived long after the death of the *Journal*. It appears that there was close sympathy between them, and it may be presumed that Mr. Featherstonhough was the instigator and prime mover of both.

[1] Response by Professor N. H. Winchell at the banquet of the Geological Society of America, Princeton, N. J., January 1, 1914.

There may have been other local geological societies in the country since 1832 whose records have not been published, but I have not heard of any.

The period of discussion and gestation prior to the birth of the present Geological Society of America extended from August, 1881, to August, 1888, *seven years*.

A few weeks before the 1881 meeting of the American Association for the Advancement of Science, at Cincinnati, Professor Chamberlin called on the speaker at his home in Minneapolis. The Western Society of Naturalists had been organized several years earlier, and one of its annual meetings was announced to take place at some point in the Mississippi Valley. In the conversation which took place in my parlor the suggestion was made by the speaker that the geologists of the western part of the country ought to be organized into a Mississippi Valley Geological Society. Professor Chamberlin immediately fell in with the idea, and it was agreed by us that the project should be broached at the approaching meeting of the American Association for the Advancement of Science at Cincinnati. But this idea expanded, in conversation with geologists at that meeting, into greater dimensions, and it was resolved to organize the geologists of America in a general society.

The first informal meeting embraced those present at Cincinnati and was held in the room of Section B, at 5 P.M., August 18, 1881. A committee was chosen to draft a constitution, consisting of George C. Swallow, of Missouri; N. H. Winchell, of Minnesota; S. A. Miller, of Ohio; Wm. J. Davis, of Kentucky; John Collett, of Indiana, and H. S. Williams, of New York.

On meeting the committee elected Winchell chairman and Williams secretary, and Miller was designated to draft a constitution for the proposed society. This constitution was presented the next day at an adjourned meeting of the committee, but after considerable discussion it was finally decided that it was best to defer more definite action to the next meeting of the American Association, and that meantime the committee prepare and distribute

widely a circular asking for the opinions of geologists generally, the replies to be reported at the next meeting of the Association, which was to be held at Montreal. Before the issuing of this circular John R. Proctor, state geologist of Kentucky, was added to the committee. This circular was drawn up by the chairman of the committee and, on submission to the members of tho committee, was approved unanimously by them. It was based almost entirely on a previous rough draft prepared by Williams and presented to the committee by him at one of the preliminary meetings at Cincinnati. Its main points are as follows:

The committees are desirous of eliciting opinions from all active and professional geologists, to the end that more judicious and effective action may be taken at the next meeting.

1. The science of geology, with its kindred branches of paleontology and lithology, has made rapid progress in America—perhaps more rapid than in any other country—in the last twenty years.

2. The literature of geology is largely distributed through numerous scientific journals, and in the proceedings of miscellaneous scientific societies, to procure which is difficult and expensive.

3. The present facilities afforded through the American Association for the Advancement of Science are insufficient, and unavailable by the working geologists of the country—because (*a*) The meetings are held in the summer, which is the geologist's working season. In order to be present he must interrupt his work and leave the field, often at considerable expense, especially if he has a party with him. (*b*) Its brief meetings partake largely of the nature of vacation pleasure-parties, and much of the time is engrossed by reception, gratulation and excursions. (*c*) There is no sufficient avenue of publication of the work of geologists. (*d*) The association has become so large, widespread and popular in its work, membership and organization that its spirit necessarily, and properly, is not favorable to the development of any special work through its own agency.

4. The geologists, as a body, have no way of expressing their views on important state, national or international measures, except through the medium of the American Association, at the meetings of which there is a perceptible and increasing lack of attendance and interest on the part of geologists, in consequence of which the actual views of the geologists of the country on such questions can not be obtained and expressed correctly.

5. There is no strictly geological magazine or journal in America.

6. There is no strictly geological society in America.

7. There are numerous such societies and journals in Europe as well as journals and societies devoted exclusively to the branches of paleontology and mineralogy.

The committee desire also to disclaim any intention to trespass on the field and plans of the American Association for the Advancement of Science, or to criticize it in any way as to the discharge of its functions. Its tendency is to popularize science and to advance its acceptance by the world by diffusing scientific knowledge, and by announcing important discoveries, and as such, its sphere of activity is one that no special scientific body can occupy, but which still will be aided by the existence of tributary organizations, such as that contemplated by this circular.

At Montreal responses were read from the following geologists: S. A. Miller, James Macfarlane, Franklin Platt, W. P. Blake, J. D. Dana, P. A. Chadbourne, J. E. Todd, E. W. Claypole, Wm. M. Davis, M. C. Read, Chas. E. Billin, W. H. Pettee, Geo. H. Stone, John Collett, R. E. Call, Warren Upham, W. G. Platt, C. A. Ashburner, R. T. Cross, G. K. Warren, A. Winchell, Robert Bell, P. W. Schaeffer, S. E. Tillman, E. O. Ulrich, C. H. Hitchcock, Edward Orton, W. J. Davis, J. W. Dawson.

The official report of the proceedings at Montreal states that A. Winchell was chosen chairman and C. H. Hitchcock secretary. Several sessions were held. Ninety answers to the circular which had been issued were reported by the chairman of the committee,

all but two of which spoke favorably of the project. The secretary (Williams) reported answers from thirty persons, and S. A. Miller reported answers from six persons, all favorable, making a total of one hundred and twenty-six opinions in favor of and only two dissenting from the formation of the proposed society.

A committee consisting of Jed Hotchkiss, R. Whitfield and C. H. Hitchcock, appointed to consider the situation, recommended that the first step to be taken should be the establishment of a geological magazine. This report was accepted and adopted; the Cincinnati committee also reported a proposed constitution, which was discussed and laid upon the table pending further labors by the committee and a report at the Minneapolis meeting in 1883.

At the Minneapolis meeting of the American Association for the Advancement of Science (1883) those who had been active for the proposed geological society met August 21, and listened to further discussions and some objections. Some dilatory motions were brought forward, viz., that a committee be appointed to confer with the Mineralogical and Geological Section of the Philadelphia Academy of Sciences with reference to the formation of an American Society and the establishment of a geological magazine. Prior to this a committee had been appointed with instructions to confer with Major J. W. Powell to ascertain what encouragement could be afforded by him in the support of a geological magazine. These special committees, however, accomplished nothing, except to delay the project, and to discourage those who were in favor of the proposed society; and the friends of the new movement became very much discouraged by the expression of unfavorable views at Minneapolis. These adverse opinions were stated by several of the oldest and most prominent geologists; and they served to dampen the ambition of those who, though younger, had been zealously promoting the proposition.

Four years later various causes led some of these opponents to change their minds and to solicit a continuation of the plan that had been proposed. And in particular the speaker recalls such correspondence with Dr. J. S. Newberry.

The chairman and the secretary of the moribund organization, Winchell and Hitchcock, convinced that nothing would be done by other parties, under implied instructions and responsibility from the meeting at Minneapolis, by virtue of their office sent out a call to meet at Cleveland, Ohio, in connection with the American Association for the Advancement of Science, 1888. The call as issued provided that the new society should be composed only of members of Section E of the American Association. This was in consequence of fear, expressed by some of the older geologists, that such an organization would clash seriously with the Association; and their love for the Association, with which they had been connected actively for many years, was greater than for any new geological organization, which appeared to them like a phantom which would be likely to have only an ephemeral existence.

Meanwhile several geologists, depending largely on the action of the Montreal meeting, and on the frequently stated advice of individual geologists, unwilling to delay longer the issuance of a geological magazine, boldly took the initiative and established the *American Geologist*, the first number appearing January, 1888. The call for the Cleveland meeting appeared in the *Geologist* for June, 1888.

It is enough to say, further, that this call met a cordial reception and that at Cleveland very much renewed interest was evident. Committees were appointed to prepare a constitution, and this constitution was adopted at a meeting held at Ithaca, New York, in December, 1888, the present meeting being the twenty-fifth anniversary of its adoption.

ALEXANDER FRANCIS CHAMBERLAIN

DR. ALEXANDER FRANCIS CHAMBERLAIN, professor of anthropology in Clark University, died April 8, 1914. He was born in Kenninghall, England, in January, 1865. In early life he came to Canada and took the degree of A.B. at the University of Toronto in 1886, and A.M.

in 1889. From 1889–90 he was librarian of the Canadian Institute at Toronto. In 1890 he was appointed to a fellowship in Clark University, where he took the Ph.D. degree in 1892. Shortly after he was appointed lecturer in anthropology and later promoted to a full professorship.

Professor Chamberlain was an expert bibliographer and editor. For many years he contributed systematic bibliographical notes to the *American Anthropologist*, which have been of great value to American students, especially since his great linguistic knowledge enabled him to give digests of all important foreign publications. It is in this respect that his loss will be most keenly felt. As an editor he was for many years in charge of the *Journal of American Folk-Lore* and actively associated with President G. Stanley Hall in the editorship of the *Journal of Religious Psychology*. He was also an associate editor of the *American Anthropologist* and of the *American Antiquarian*. He was an important contributor to the *Encyclopedia Britannica* and many other reference books. As a writer, he possessed more than average skill, having contributed many charming articles to the *Atlantic Monthly* and other magazines.

His special line of research was linguistics. In 1891 he made a special study of the Kootenay Indian language of British Columbia under the auspices of the British Association and collected considerable data on their culture; unfortunately, the greater part of this is still unpublished. In addition to the study of certain Algonkin linguistic problems, Professor Chamberlain worked over the linguistics of South America and prepared a map of the continent similar to the famous Powell map of North America. This work was recently published and, though still to occupy the attention of the author, had he lived, is probably about as complete as the data available make possible. Though necessarily tentative, it marks a distinct advance in South American anthropology.

His best known works are the "Child and Childhood in Folkthought" (1896) and "The Child: A Study in the Evolution of Man" (1900), subjects which were quite suggestively developed in his lectures to students of psychology and education. C. W.

THE GENERAL EDUCATION BOARD

The spring meeting of the General Education Board—the foundation endowed by Mr. John D. Rockefeller—was held on May 29. In attendance were Chas. W. Eliot, Albert Shaw, H. B. Frissell, Anson Phelps Stokes, John D. Rockefeller, Jr., F. T. Gates, E. L. Marston, Jerome D. Greene, Starr J. Murphy, Wallace Buttrick and Abraham Flexner. Ambassador Page, President Judson and Dr. Wickliffe Rose were absent abroad. The membership of the board was increased by the election of President George E. Vincent, of the University of Minnesota.

At the close of the meeting announcement was made that appropriations aggregating $1,400,000 had been made. The most important of these was a gift of $500,000 to the medical school of Yale University. As had been previously announced, the General Education Board has decided to provide funds necessary to enable properly located and organized medical schools to command the entire time and energy of their teachers in the main departments of medicine and surgery. For this purpose a million and a half dollars has already been appropriated for the Johns Hopkins School, and $750,000 for Washington University. This gift of $500,000 to the Yale Medical School was made on condition that the school procure complete teaching and medical control of the New Haven Hospital, and that the teachers in the main clinical branches be placed on the full-time or university basis.

In conformity with its previous policy of making gifts to increase the endowment and extending the usefulness of promising and serviceable institutions in various parts of the country, the following appropriations were made:

Stevens Institute of Technology	$250,000.
Elmira College	100,000.
Hendrix College	100,000.
Washington and Lee University	125,000.
Wells College	100,000.
Wofford College	83,000.

Increased appropriations were made to develop the work in secondary education which the board has been carrying on in the south for ten years. The board has maintained professors of secondary education in southern universities and inspectors of secondary schools who have devoted their time to the creation and development of high schools in their several spheres.

The sum of $36,500 was appropriated for the maintenance of rural school supervisors in each of the southern states. These supervisors are concerned with the improvement of country schools and with the introduction into them of industrial training and domestic science. The annual subscription of $10,000 toward the current expenses of Hampton Institute was increased to $25,000, an annual subscription of $10,000 was made to Tuskegee Institute, and one of $15,000 to Spelman Seminary, Atlanta.

Farm demonstration work on an educational basis was originated by the General Education Board. The plan was conceived by the late Dr. Seaman A. Knapp. So far as the southern states are concerned, congress now assumes the work heretofore supported by the General Education Board, objection having been made to the payment of the officers of the Department of Agriculture by a private contribution. The board will, however, continue its co-operation with agricultural colleges in the work. For this purpose, $20,000 was appropriated for farm demonstration in six counties in Maine and for boys' and girls' clubs in that state. A further appropriation of $10,000 was made for similar work in New Hampshire.

To improve education in the rural districts the board has resolved to offer to support in connection with state departments of education, rural school agents. An appropriation of $50,000 was made for the work in fifteen states. A general agent will be appointed to keep the several state movements in touch with one another. The board resolved to authorize a study of training for public health service and of the organization of public health service in England, Germany, Denmark and other foreign countries. When the facts have been ascertained a conference will be held and a concrete scheme formulated for schools of public health.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

THE fourth annual meeting of the Pacific Association of Scientific Societies was held at the University of Washington, Seattle, May 21–23, 1914. There were about 150 men from the Pacific coast and from Hawaii attending the various societies meeting at that time. Of the sixteen constituent societies the following held meetings: The Cordilleran Section of the Geological Society of America, The Seismological Society of America, Pacific Coast Branch of the American Historical Association, The Pacific Slope Association of Economic Entomologists, Pacific Coast Palæontological Society, The Cooper Ornithological Club, Biological Society of the Pacific Coast, California Section of the American Chemical Society, Puget Sound Section of the American Chemical Society, and the San Francisco Section of the American Mathematical Society. The following societies did not hold meetings at this time: The Technical Society of the Pacific Coast, California Academy of Sciences, Astronomical Society of the Pacific, The Geographical Society of the Pacific and the San Francisco Society of the Archeological Institute of America. In addition to the above eleven societies of the Pacific Association the following six societies of the Pacific Northwest joined with the Association: Seattle Society of the Archæological Institute of America, Oregon Section of the American Chemical Society, The Northwest Association of Teachers of History, Government and Economics, Inter-Mountain Section of the American Chemical Society, The Le Conte Club, the proposed Pacific Coast Branch of the American Political Science Association and the Washington Society of Social Hygiene.

The general session of the Association was held on Saturday evening, before which spoke Acting President Landes, of the University of

Washington. President J. C. Branner, Stanford University, gave an address on "Science and the State." Dean J. Allen Smith, University of Washington, read a paper on "The Citizen and the State." The third paper was given by Professor J. C. Merriam, University of California, on "The Geological History of the Human Family and Its Bearing on the Race Problem." In 1915 the Pacific Association will hold no meetings; the constituent societies will join with their eastern societies at the Fair at San Francisco. At this meeting of the association a constitution was approved by the executive committee whereby the Pacific Association will become the Pacific Division of the American Association for the Advancement of Science. The constitution was referred to the constituent societies for their action. Since there is to be no meeting in 1915 the change of associations is to take place at the end of the 1915 meeting of the American Association at San Francisco in August of that year, provided that by that time two thirds of the constituent societies have approved and signed the constitution and also provided that the Pacific Division is ready with its officers to take up the work of the Pacific Association.

SCIENTIFIC NOTES AND NEWS

Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, has been elected a corresponding member of the Paris Academy of Sciences in the section of anatomy and zoology, in succession to the late Lord Avebury.

Professor John Howard Appleton, for over fifty years an instructor at Brown University and since 1868 head of the department of chemistry, will retire at the end of the present academic year with the title of professor emeritus.

At the celebration of the seventy-fifth anniversary of the founding of the University of Missouri, held at Columbia, Mo., June 3, Professor Cassius J. Keyser delivered an address on behalf of the alumni. At the commencement exercises the university conferred upon him the degree of doctor of laws.

Dr. Mark J. Scheonberg has received the Lucien Howe prize of the Medical Society of the state of New York for his research work on ocular anaphylaxis.

Mr. Clifford Richardson, consulting engineer, has been elected president of the Association of Harvard Chemists, and vice-president of the Harvard Engineering Society of New York, for the ensuing year.

Dr. Theodore C. Merrill, recently assistant pathologist in the office of forest pathology of the Bureau of Plant Industry, has been appointed medical assistant in the Bureau of Chemistry.

The C. M. Warren committee of the American Academy of Arts and Sciences has made the following grants:

To Professor George H. Burrows, of the University of Vermont, a grant of $250 for work connected with the measurement of equilibrium concentrations in certain reactions of organic chemistry, with the special purpose of determining the free energies of formation of the compounds involved.

To Professor R. F. Brunel, of Bryn Mawr College, an additional grant of $400 for the purchase of a polarimeter to be used in connection with his work on equilibria in organic reactions in which optically active radicals are concerned.

To Professor S. Lawrence Bigelow, of the University of Michigan, a grant of $200 for the promotion of his study of osmotic membranes, especially those of a metallic nature.

Mayor Mitchel, of New York City, accompanied by President Thomas Churchill of the Board of Education and City Chamberlain Henry Bruere, have this week visited cities of the central west to inspect their public schools and teaching systems.

The Harrington lectures of the medical department of the University of Buffalo, by Professor Ludwig Pick, of Berlin, were announced for the evening of June 2 and in the afternoons of June 3 and 4. The title was "Some Recent Advances in Pathological Anatomy."

Dr. Ira Remsen, of the Johns Hopkins University, addressed a large University of Illinois audience on May 18. His subject was "My Acquaintance with Liebig and Wohler."

He addressed the members of the Chicago Chapter of the Sigma Xi at their Spring Quarter dinner on May 19 upon "Reminiscences of Rowland and Sylvester."

AT the graduate school of agriculture, to be held at the University of Missouri, Columbia, Mo., June 29–July 24, a course of forty lectures on genetics will be given by Professor A. D. Darbishire, of the University of Edinburgh; Professor E. M. East, of Harvard University; Professor M. F. Guyer, of the University of Wisconsin, and Dr. J. A. Harris, of the Carnegie Institution. Dr. Otto Appel, of the Imperial Biological Institute at Dahlem, Berlin, will lecture at this school on the diseases of potatoes and cereals.

AT the 329th meeting of the New York Electrical Society, held at Columbia University, on May 25, Dr. L. A. Bauer gave an illustrated lecture on "The Non-magnetic Yacht *Carnegie*, Her Work and Her Cruises." This was followed by a brief informal talk on "Aerial Navigation," by Lieut. John Cyril Porte, R. N., with especial reference to the proposed Rodman Wanamaker transatlantic flight.

THE University of Pennsylvania library has received through Dr. John K. Mitchell and Mr. Langdon Mitchell about 500 volumes, forming a portion of the library of their father, the late Dr. S. Weir Mitchell.

THE class of 1910, general science course, has presented to the Cooper Union, New York City, a memorial tablet for the late Professor William A. Anthony. Mr. John F. Hanbury, a graduate of the class, said that Professor Anthony had established at Cornell University the first electrical course either in Europe or America. Professor Edward L. Nichols, of Cornell, and President John W. Lieb, of the New York Edison Company, gave tributes to the genius of Professor Anthony.

THE University of Birmingham council has passed the following resolution: "That the council desires to record its deep sorrow at the death of Professor Poynting, who so faithfully served the Mason College and the university for thirty-four years. During his distinguished career as professor of physics he was not only an inspiring teacher and investigator, but bore a considerable part in the development of the college and of the university. His keen interest in all that concerned the university, its staff, and its students, his genial and attractive personality, will be long and affectionately remembered; his death leaves a gap which it will be most difficult to fill."

DR. ALFRED E. BARLOW, of Montreal, distinguished for his work in Archean and mining geology, a former member of the Geological Survey of Canada and former president of the Canadian Mining Institute, was drowned in the wreck of the "Empress of Ireland" on May 29. Dr. and Mrs. Barlow were together on a vacation trip to England and both were lost in this terrible catastrophe.

WE regret also to announce the untimely death, at the age of thirty-eight years, of Jesse J. Myers, assistant professor of physiology and zoology at the Michigan Agricultural College, East Lansing, Michigan. Professor Myers was born in Illinois and graduated at the University of Illinois with the degree of B.S. in 1901. Since then he has been on the staff of the Michigan institution, having spent some of his vacation months in study at the Universities of Illinois and Wisconsin. Early in April he went to New Haven to enter the Sheffield laboratory of physiological chemistry of Yale University; and he died after a very brief illness from typhoid fever in that city on May 28.

DR. PAUL VON MAUSER, inventor of the Mauser rifle, has died at Berlin, aged seventy-six years.

THE U. S. Senate has passed the Agricultural Appropriation bill, with a provision prohibiting the acceptance by government employees of funds from the General Education Board or similar institutions.

THE Army appropriation bill that passed the U. S. Senate some weeks ago provides that the appropriation for the library of the Surgeon-General's Office shall be conditional on the merging of this library with the Congressional Library. Neither the surgeon-general

nor the librarian of congress was consulted, and the plan is opposed by them and by all well-informed physicians and men of science. It may be assumed that the amendment will not be concurred in by the House, after the question has been brought properly to its attention.

The Association of German Men of Science and Physicians will hold its eighty-sixth annual meeting this year at Hanover from September 20 to 26.

The international committee for the International Congress of Anatomy has decided that the next meeting shall be held at Amsterdam during August, 1915.

The Eugenics Research Association will hold its next annual meeting on Friday, June 19, and Saturday, June 20, 1914, at Schermerhorn Hall, Columbia University, New York City. The program will consist of papers by members, a symposium upon the subject: "The most pressing topics for research in eugenics," open discussions, and a general experience meeting for institutional officers and eugenics fieldworkers. In order that the details of the program of papers may be completed as early as possible, contributors are requested to notify the secretary *not later than May 21*, giving the title of the paper and the amount of time required.

Sir Arthur Evans has presented to the museum of the University of Cambridge the last instalment of a set of objects selected from the collections of his father, the late Sir John Evans. The gift consists of 121 specimens ranging in date from prehistoric times to the eighteenth century. All the specimens were found in Cambridgeshire and the adjacent counties.

Mrs. Russell Sage has given to the State Museum, Albany, a series of 106 bird paintings by Louis Agassiz Fuertes, of Ithaca. The exact amount contributed was not made public. These paintings were made by Mr. Fuertes within the last two or three years for reproduction in a comprehensive book on the birds of New York State.

Bulletin 553 from the Harvard College Observatory signed by the director, Dr. Edward C. Pickering, and dated May 26, states that a cablegram received at this observatory on May 21, from Professor C. D. Perrine, director of the Observatorio Nacional, Cordoba, Argentina, states that the orbit of Zlotinsky's Comet is found to be similar to that of Herschel's Comet of 1790. Professor Edwin B. Frost, director of the Yerkes Observatory, writes that the comet was seen by several observers on May 20 and 22 with the naked eye. Estimates of its magnitude on May 22, with a clear sky, determined it to be equivalent to a fifth magnitude star. Photographs were obtained by Professor Barnard on May 18, 20 and 22, the last of which showed a tail at least 12° long, extending to the edge of the plate, resembling the tail of Gale's Comet as photographed by Professor Barnard in 1912. Photographs by Mr. Parkhurst with a 15° U. V. objective prism, May 20 and 22, show the usual commentary spectrum with large knots representing the CN band (λ3883), and the blue band (λ4737), known as the "fourth carbon," beside numerous fainter ones. On May 20 the green band (λ5165), known as the "third carbon," was well shown.

UNIVERSITY AND EDUCATIONAL NEWS

A gift of $100,000 for the erection of the first of Cornell University's residential dormitories is announced. The name of the donor is withheld.

Nathaniel H. Stone, of the class of 1875, has made an unrestricted gift to Harvard University of $50,000 in memory of Henry Baldwin Stone of the class of 1873.

The University of Pennsylvania is given $25,000 under the will of Miss Elizabeth S. Shippen.

Mr. Robert C. Ogden bequeathed $20,000 and a contingent interest in one third of a $50,000 fund to the Hampton Normal and Agricultural Institute.

The supreme court of Massachusetts has decided that the Massachusetts Institute of

Technology may sell its Boylston street land, but only subject to the restrictions and encumbrances of abutters established by the grant of the land to the institute in 1861 by the legislature. The institute will therefore probably retain its present site for part of its work.

Appointments, including changes in title, have been made at Harvard University as follows:

Comfort Avery Adams, Abbott and James Lawrence professor of engineering.

Masaharu Anesaki, professor of Japanese literature and life.

Edwin H. Hall, Rumford professor of physics.

Elmer Peter Kohler, Abbott and James Lawrence professor of chemistry.

Roger Irving Lee, professor of hygiene.

Manoel de Oliveira Lima, professor of Latin-American history and economics.

Robert Williamson Lovett, professor of orthopedics.

William Fogg Osgood, Perkins professor of mathematics.

Wallace Clement Sabine, Hollis professor of mathematics and natural philosophy.

Frank Lowell Kennedy, associate professor of engineering drawing.

Howard Thomas Karsner, assistant professor of pathology.

At Clark College Dr. Robert H. Goddard, late research fellow in Princeton University, has been appointed instructor in physics. Professor Carey E. Melville, assistant professor of mathematics, has taken on the duties of registrar of the college.

Dr. Samuel Rittenhouse, professor of biology at Olivet College, has been elected associate professor of zoology in the University of Southern California.

Dr. John W. Cox, graduate of the Syracuse University College of Medicine in 1912 and afterward instructor in pathology at Syracuse, has been appointed assistant professor of pathology in the State University of North Dakota.

Dr. A. F. Shull, assistant professor of zoology in the University of Michigan, has been promoted to a junior professorship.

Ryland M. Black, A.M., professor of history and political science in the State Science School, Wahpeton, North Dakota, has been elected to the presidency of the State Normal Industrial Institute at Ellendale of that state.

Mr. G. P. Thomson, scholar of Trinity College, Cambridge, and son of Professor Sir J. J. Thomson, has been appointed to a mathematical lectureship at Corpus Christi College.

DISCUSSION AND CORRESPONDENCE

HAS THE WHITE MAN MORE CHROMOSOMES THAN THE NEGRO?

In a recent number of Science (May 15, 1914), Professor Michael F. Guyer complains that in my recent book on "Heredity and Sex" I have given an erroneous impression concerning the relation of his work on human spermatogenesis to that of Montgomery on the same subject. Professor Guyer objects to my statement that while Montgomery's account confirms his own as to the number of the chromosomes it "is in disagreement in regard to the accessory." I think my statement is correct, but in order that the reader may judge for himself, let me quote Montgomery's own summing up:

> But Guyer concluded that the two allosomes [sex chromosomes] always pass undivided to one spindle pole in the primary spermatocytes, reaching then only half of the secondary spermatocytes, and in these dividing presumably equationally. He consequently argued two classes of spermatozoa are produced in equal numbers. . . . That is to say, he overlooked the variability in behavior of the allosomes specially studied by me.

After giving his reasons for thinking that this *variability* in the behavior of the allosomos is a normal process, Montgomery concluded that there would "be four classes of spermatozoa and not simply the two classes distinguished by Guyer" (p. 10). And in another connection Montgomery writes

> . . . if there be only two classes of sperm, as Guyer argues, and one kind of egg, this should result in equal numbers of the sexes and not in the ratio actually known.

These comparisons that Montgomery has himself made seem to more than justify my

remarks that he is not in agreement with Guyer in regard to the accessory. Guyer refers to this matter as only a "slight discrepancy" but to my own way of thinking, it is the only evidence (in default of better evidence, unfortunately) on which we can at present judge concerning the nature of these bodies that Guyer identifies as the sex chromosomes. Irrespective, therefore, of whether Guyer is right or wrong, it still seems to me that Montgomery's statements can not properly be said to be like those of Guyer except for a "slight discrepancy."

It may be invidious to point out here that the kind of evidence that Guyer admits in favor of the two chromosomes in man being sex chromosomes is of the same sort as the evidence that he has brought forward for similar bodies in birds. The recent thoroughgoing analysis of Pearl and Boring has made apparent that this kind of evidence is in itself inconclusive and unconvincing. The experimental evidence indicates very strongly that in birds the female is heterozygous for a sex factor.

There is another and not unimportant difference between Guyer and Montgomery. Guyer states that a second pairing of the ordinary chromosomes takes place in man. Montgomery says:

> I have seen no evidence of any kind of such a pairing of chromosomes in the secondary spermatocytes, neither in my own material nor in that received from Guyer, though I have examined fully two hundred division stages of these cases.

While the second point does not bear directly on the "disagreement" in regard to the sex chromosomes, it raises a doubt as to the value of material that can lead to such diametrically opposed results, for the conflicting statements relate to the same identical preparations.

In order that no misunderstanding may arise I may add that I am entirely in sympathy with the view that in the human race the male is heterozygous in a sex factor; for the experimental evidence relating to sex-linked inheritance strongly indicates that this is the case.

It is with great interest I note in the last paragraph of Guyer's paper a hint (or is it intended as an announcement?) that the white man has more chromosomes than the negro—a point of view I mentioned[1] in the book under discussion as a possible way of harmonizing Guyer's results with those of v. Winiwarter. If the suggestion is established, some revision may be necessary concerning the Mendelian expectation for the inheritance of skin color in the black-white cross.

T. H. Morgan

SCIENTIFIC BOOKS

Introduction to the New Statistics with Special Reference to the Needs of Biologists

The number of guides to modern statistical methods consequent upon the realization that mathematical analysis is necessary for the full interpretation of series of observations is now so large that it may be helpful to the beginner to point out some of their chief features.

While Francis Galton's "Hereditary Genius" of 1869 shows the influence of the work of Quetelet, his "Natural Inheritance" of 1889 is probably the first book published in which the modern student can find any consistent comprehensive explanation of the statistical methods as applied to biological problems. While this classic should be familiar to every statistician, it is not suitable as a guide to the beginner, for the formulæ there described have been replaced by those better suited to the practical routine of calculation.

Among the earlier treatises on the new statistics—speaking now of introductions and guides, not of original work—may be mentioned those of Duncker[1] and Davenport[2] written from the standpoint of methods and the volume of Vernon[3] prepared more as a

[1] First suggested in 1912 by Gutherz but rejected by him.

[1] Duncker, G., "Die Methode der Variationsstatistik," *Archiv. f. Entwicklungsmechanik d. Organismen*, Vol. VIII., pp. 112–183, 1899.

[2] Davenport, C. B., "Statistical Methods with Special Reference to Biological Variation," New York, 1899, second ed., 1909.

[3] Vernon, H. M., "Variation in Animals and Plants," New York, 1903.

summary of progress in the study of variation, but giving some elementary explanations of methods.

Of more recent works those of the greatest value have appeared in the English language. It would have been too much to expect that the influence of the newer work would extend as far as Madrid and affect the "Tratado Elemental de Estadistica" of Menguez y Vicente (1907) but something better might have been expected of France and Germany. How backward they are can be seen from such essays as Žižek's "Soziologie und Statistik," München und Leipzig, 1911, or those in the "Festschrift" for Georg von Mayr, "Die Statistik in Deutschland nach ihrem heutigen Stand," München und Berlin, 1911. Such works as F. Faure's "Elements de Statistique" and Maciejewski's "Nouveau Fondements de la Theorie de la Statistique" (1911) have, in spite of their attractive titles, no practical value to the biologist—or, as far as the present reviewer can see, to any one else. Nor can anything be said in favor of Al. Kauffmann's "Theorie und Methoden der Statistik," just published (Tübingen, 1913).

Forscher's recent book[4] seems to be a serious attempt, apparently done in almost complete ignorance or with all but a total disregard of the fundamental calculus of the English school, to obtain a better theoretical (mathematical) basis for statistical formulæ. Of the soundness of the mathematical work, I am not able to judge; nor does it particularly concern us here, for practically—that is, as a tool for the man grappling with practical statistical problems—the work has little immediate value.

Turn now to introductory works which may be of value to the beginner.

Many biologists and others are very deeply indebted to the sections on Heredity, Selection and Evolution in the second edition of Pearson's "Grammar of Science" for their first knowledge of the new methods. The second edition is out of print, but a third is being issued.

"The Primer of Statistics" (London, A. & C. Black, 1909) prepared by the Eldertons at the suggestion of Sir Francis Galton is for the general public rather than for one who hopes to prepare for investigation. King's little book[5] although containing something of the newer methods is for the social rather than for the biological student and is far too elementary for those who wish to do research work. Elderton's book[6] not only embodies the actuaries' viewpoint, but presupposes the actuaries' training. Thus as a *first* book it is quite beyond the depth of the average biologist, but if he is working seriously in statistics it is most helpful on his table.

That Eugene Davenport's book[7] on breeding—with all its points concerning which the doctors in mathematics and the doctors in biology will disagree—is a pretty good introduction for a certain class of readers is perhaps sufficiently established by the influence which it has evidently exerted in our agricultural institutions. One recognizes the scissors and paste nature of the volume, but this characteristic it shares with practically all the other introductions to statistical methods: the compilation is only a little more obvious and the compiler distinctly more honest in the acknowledgment of original sources than is sometimes the case.

Thorndike[8] several years ago prepared an introduction for the use of psychologists which has recently (1913) been issued in a much-amplified second edition. The work is more elementary and far more verbose than the book by Brown.[9] For this reason, Thorndike's text

[4] Forscher, H., "Die Statische Methode als Selbstandige Wissenschaft. Eine Einführung in deren Fundamente und Grundzüge," Leipzig, 1913.

[5] King, W. I., "Elements of Statistical Method," New York, Macmillan, 1912. *Cf.* SCIENCE, N. S., Vol. 36, p. 519, 1912.

[6] Elderton, W. P., "Frequency Curves and Correlation," London, C. & E. Layton, 1906.

[7] Davenport, E., "Principles of Breeding," with an appendix on Statistical Methods by H. L. Rietz, 1907.

[8] Thorndike, E. L., "An Introduction to the Theory of Mental and Social Measurements," New York, 1904.

[9] Brown, W., "The Essentials of Mental Meas-

is better as an introductory work for most American students, while Brown's more technical and more comprehensive book is indispensable to those who care to do really serious research. In this connection the work of Urban[10] may also be mentioned.

The most comprehensive text on modern statistics—an introduction to statistical theory rather than a guide to the application of statistical analysis in any particular field—is that of Yule,[11] who has brought to his task the training of an assistant in Karl Pearson's laboratory. To all those who must use statistical formulæ without being able to read with ease the fundamental papers—and this comprises all but a handful of the workers—Yule's book is indispensable. The simpler statistical processes are all treated with care and clearness, and with a terseness refreshing after the verbiage of works written from the biological viewpoint. One must commend the careful system of cross reference, which should greatly facilitate the use of the book, and the very complete and annotated bibliography which should inspire the student to study original sources. The student, moreover, should remember that even Mr. Yule's book does not render this unnecessary, for in the text some subjects of great importance are not treated at all. For example, one misses a discussion of Pearson's various types of frequency curves which have been used with such success for the past several years in describing a great variety of phenomena. The classical fourfold correlation method is also omitted. The most flagrant fault of the book is the putting forward of certain measures of association and correlation, which are worthless,[12] but which, because of their simplicity, are likely to be widely used by those who prefer ease of calculation to correctness of result.

urements,'' Cambridge University Press, 1911.

[10] Urban, F. M., ''The Application of Statistical Methods to the Problems of Psycho-Physics,'' Philadelphia, 1908.

[11] Yule, G. U., ''An Introduction to the Theory of Statistics,'' London, Chas. Griffen and Co., 1911, 2d edition later.

[12] See Heron, *Biometrika*, Vol. 8, pp. 109–122, 1911; K. Pearson and D. Heron, *Biometrika*, Vol. 9, pp. 159–315, 1913.

The guides which are available the beginner must use: but he should know that there is not only no royal road, but as yet no Baedeker, to statistical analysis. Here, as is wont to be the case with text-books, the guides have for the most part been written by men who have not distinguished themselves by exploration into the territory through which they now propose to lead others. The real student will, therefore, be vigilantly skeptical, and will go as far as he is able to the original sources to read and weigh for himself.

Taking the books mentioned in this review as a class, the greatest criticism that can be made is not that there are blunders in statement and misprints in formulæ, but that throughout there is an incautious attitude towards the real difficulties which the student is to encounter, or even a positive assurance that dangers are only apparent. Nothing could be farther from the truth, for in higher statistics innumerable pitfalls surround the investigator. Serious harm has been done by telling the beginner that he need not understand the formulæ to use them. Neither is it necessary for a chemist to understand his reagents! To be sure, most of us have of necessity to work with but little knowledge of the mathematics which lie back of the formulæ, but it is the obvious duty of the student who proposes to use these newer tools of research to learn all that he can concerning the assumptions upon which the formulæ rest in order that he may apply them with intelligence.

Finally, the beginner must realize that it is as impossible to gain a working knowledge of statistical methods from a text-book without experience in the routine of measurement, computation and interpretation as to acquire proficiency as an organic chemist outside the laboratory. It takes years of hard work to make a proficient biometrician—although some have to their own satisfaction qualified for the writing of texts much more easily.

J. Arthur Harris

THREE TEXT-BOOKS IN BIOLOGY

The Principles of Biology. By J. I. HAMAKER. Philadelphia, P. Blakiston's Son & Co. 1913. 8vo. Pp. x+459. 267 illustrations.

Within the brief space of 438 pages, the author of this little volume has condensed a large amount of accurate information. As is stated in the preface, the book has been prepared as a substitute for the lecture notes of the ordinary pupil and of its superiority over such sources of information, or misinformation, there can be no doubt. After a very brief introduction, there follows over a hundred pages on plant biology and over three hundred on animals. Brief laboratory directions are included and a great variety of subjects are dealt with. A general review of plant physiology is followed by an account of the classes of plants and a consideration of their ecology. In a similar way the general physiology and morphology of animals is followed by a description of the classes of the animal kingdom. The whole account is concluded by an interesting section on general principles such as the structure of the cell, embryology, origin of species, adaptations, etc. In fact the list of headings at once indicates the scope and shortcomings of the book, for with so much to be covered and with so little space in which to do it, much of the treatment is necessarily abridged and inadequate. Yet as a condensation the volume has many points in its favor. The illustrations are often very good, particularly some of those taken from photographs of the original objects.

Elementary Biology. Plant, Animal, Human. By J. E. PEABODY and A. E. HUNT. New York, The Macmillan Company, 1913. 8vo. Pp. xxi + 170 + 194 + 209. Over 300 illustrations.

This volume is avowedly intended for high schools and covers those parts of botany, zoology and a study of the human being that are most worthy of emphasis. The general structure and physiology of plants is first dealt with, then their relation to human welfare, and finally their classification. Under animal biology chapters are devoted to insects, birds, frogs, fishes, crayfishes and their allies, and the one-celled animalcules. The remaining groups of the animal kingdom are briefly considered in a final chapter. The section on man is mostly concerned with his physiology. The chapter on stimulants and narcotics is particularly to be recommended in contrast to similar chapters in the older school physiologies. There is an appendix that contains many useful suggestions to the teacher and the volume is concluded by a good index. Most of the illustrations are excellent, but in Fig. 26 the size of the head in comparison with that of the viscera is quite misleading and Fig. 99 is unnecessarily crude. It is to be regretted that the three sections of which the book is composed should have been separately paged and their figures separately numbered. It is difficult to see how this can be anything but an inconvenience unless it is intended to allow the publisher to divide the book easily into its three separate parts.

An Introduction to Zoology. By R. LULHAM. London, Macmillan and Co., Limited, 1913. 8vo. Pp. 457. 328 illustrations.

This volume is on most conservative lines even to the classical quotation preceding the introduction. It takes up in methodical fashion group after group of the invertebrates and thus includes an account of all the chief divisions of the lower animals. The author believes there is place for such a compact volume as this and that it should be read by those pupils who spend much of their time in the laboratory. The book is like so many that have been published in the last decade that it carries scarcely the air of novelty. In a reading text such as this it is unfortunate that so interesting and important a group as the chordates should have been intentionally omitted. For originality of treatment and an air of modernity this volume is much behind the other two already noticed.

G. H. PARKER

THE ATOMIC WEIGHT OF LEAD OF RADIO-ACTIVE ORIGIN

THE atomic weight of lead obtained from radioactive minerals has recently been studied

by Professor Theodore W. Richards, of Harvard University, and Mr. Max E. Lembert, who came to America from the Grand Ducal Technical School of Karlsruhe for this purpose, on the initiative of Professor Bredig and Dr. Fajans. The latter well-known investigator, as well as Sir William Ramsay, Professor Boltwood, Miss Gleditsch and Mr. Miner generously provided the experimenters with residues containing lead of this sort. It was found that all the lead obtained from uraninite, carnotite or thorianite exhibited a lower atomic weight than ordinary lead, the deficiency amounting in one case to as much as 0.75 unit. The ultra-violet spectrum of a typical specimen appeared to be exactly identical with that of ordinary lead. The necessary inference seems to be that lead from radioactive sources consists of a mixture of at least two substances, of which one is ordinary lead. The foreign substance must be very similar to ordinary lead and very difficult if not impossible to eliminate by chemical means; for many precautions were taken to purify the samples. This amazing outcome is contrary to Harvard experience with several other elements, notably copper, silver, iron, sodium and chlorine, each of which has been found to have a constant atomic weight, no matter what the source may have been. The new results on radioactive lead are qualitatively in accord with a recent hypothesis brought forward independently by Fajans, by Russell, and by Soddy, although quantitatively not exactly consistent with it. A preliminary paper, setting forth the detailed methods and results, was sent to press on May 14, and will appear in the July number of the *Journal of the American Chemical Society*. The research was generously subsidized by the Carnegie Institution of Washington.

SPECIAL ARTICLES

THE PRODUCTION OF MALES AND FEMALES CONTROLLED BY FOOD CONDITIONS IN HYDATINA SENTA

THE factors that regulate the production of the sexes in the rotifer *Hydatina senta* have been zealously sought for during the past twenty-five years and various results have been obtained. Temperature, starvation of the young females, unknown external agents, and finally the intangible unknown internal factors, have been decided to be the potent influences that regulate the sex ratio in the parthenogenetic reproduction.

Mitchell[1] has recently experimented with the rotifer *Asplanchna* and has found that a sudden change of the food will bring about the production of a certain one of the polymorphic forms of this rotifer. This particular form of the female produces males. He therefore concludes that a change of food eventually causes male individuals to be produced. He suggests that this food factor may be found to regulate the sex production in *Hydatina senta*.

Some time ago it was shown by Whitney[2] that uniform food conditions caused a production of only females for 289 generations in *Hydatina senta*. Since that time many attempts have been made to find some food conditions that would cause the females to produce only male offspring. Many kinds of mixed cultures of various protozoa have been tried as food and a varied assortment of results have been obtained. This winter pure cultures of several species of protozoa have been grown and more definite results have been obtained. Several kinds of colorless flagellates as well as several kinds of green flagellates were reared and used as food for *Hydatina senta*. Some were tried as a continuous diet and others were used in an interrupted diet. The colorless flagellate, *Polytoma*, was found to be the most satisfactory as a continuous diet for producing only female offspring. A species of the green flagellate *Dunaliella* (Teodor) or *Chlamydomonas* (Cohn) was found to be the most effective in causing the females to produce a high percentage of male offspring by an interrupted diet.

Some fertilized eggs were taken in November from a covered culture jar of rotifers that

[1] *Jour. Exper. Zool.*, Vol. 15, August, 1913.

[2] *Biol. Bull.*, Vol. 22, 1912.

was made in 1908 and had been standing unchanged since that time. A general new culture of rotifers was made from these fertilized eggs and then a few females were selected at random and fed upon a continuous diet of the colorless *Polytoma* in watch glasses. After a few generations a very high percentage of females were produced. At this period adult females were taken from several of the watch glasses and placed in some filtered water from a jar in which a general culture of rotifers were thriving. Then there was added to this culture water the green flagellate, *Dunaliella*.

Experiment	Continuous Polytoma Diet			Adult Females taken from Cultures that had been Living on a Continuous Diet of *Polytoma*, a Colorless Flagellate, for Several Generations and Put upon a New Diet, the Green Flagellate, *Dunaliella*														
	Control			Lot A			Lot B			Lot C			Lot D			Lot E		
	Adult Females	Daughters	Per Cent. of ♂♀[3] Daughters	Adult Females	Daughters	Per Cent. of ♂♀ Daughters	Adult Females	Daughters	Per Cent. of ♂♀ Daughters	Adult Females	Daughters	Per Cent. of ♂♀ Daughters	Adult Females	Daughters	Per Cent. of ♂♀ Daughters	Adult Females	Daughters	Per Cent. of ♂♀ Daughters
1	5	52	9+	5	50	78	5	47	80+	5	54	75+	5	60	80	5	54	83+
2	5	60	3+	5	51	83+	5	50	74	5	56	82+	5	54	81+			

The controls were also placed in this filtered culture water and the colorless flagellate *Polytoma* was added.

The above table giving the details of two experiments shows the decided and striking results obtained. The continuous diet of *Polytoma* caused the adult females to produce 6 + per cent., as an average, of daughters that were male-producers, while the diet of the green *Dunaliella* that was given to the other adult females caused them to produce as an average 79 + per cent. of daughters that were male-producers.

These experiments are not exceptional, but are only two from many others already completed that are equally as good as these and which were obtained in a series of successive experiments. In all other experiments during the last eight years on *Hydatina senta* there has occurred from time to time a sudden production of males, but such experiments never could be repeated with equal success. Now the male-producing females can be caused to appear at any time from any stock in the laboratory by the sudden change from a continuous diet of *Polytoma* to a diet of the green *Dunaliella*.

Several other green flagellates have been reared and used as food, but they do not seem to be effective in causing males to be produced. Many other observations are being made in a further study of the problem, and the detailed results together with the exact methods used will be published in a later paper.

D. D. WHITNEY

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MIDDLETOWN, CONN.

[3] Females which produce male offspring.

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society was held in the rooms of the society in Philadelphia, April 23 to 25 inclusive, and constituted a most interesting series of sessions. There was a large number of papers presented, their general character being of a high order of merit and the scope of subjects included being wide.

The meeting was opened on Thursday afternoon, President W. W. Keen, LL.D., in the chair, when the following papers were read:

The Physical Cause of the Unsymmetrical Equilibrium of the Earth Between the Land and Water Hemispheres, with a Theorem on the Attraction of the Terrestrial Spheroid: T. J. J. SEE.

Some Observations on the Psychology of Juries and Jurors: PATTERSON DU BOIS, ESQ.

Factors of Influence in the Origin and Circulation of the Cerebro-spinal Fluid: CHARLES H. FRAZIER.

Aspects and Methods of the Study of the Mechanism of the Heart Beats: ALFRED E. COHN. (Introduced by Dr. Keen.)

Interest in the mechanism of the heart-beat was stimulated by the discovery that the electric currents which the heart discharged during contraction could be registered by a moderately sensitive, but rapidly reacting galvanometer. A general use of such galvanometers was introduced in 1906–08. At the same time structures dealing with impulse formation (the sino-auricular node of Keith and Flack) and conduction (the auriculo-ventricular node of Aschoff-Tawara and the auriculo-ventricular bundle of Kent and His, Jr.) in the heart were discovered. These discoveries form the basis of contemporary studies.

The various waves which are found in the electrocardiogram, which is the name given to the photographed curves of the cardiac action currents, have been identified as representing definite events in the cardiac cycle. The validity of electrocardiograms as records has been established, not only for different classes of animals, but for species as well. So far as man is concerned, records can be differentiated as between individuals, and the record of the individual recognized over long periods of time as peculiarly his own. This individuality of records applies not only to normal, but also to abnormal conditions.

Alterations in the established form of electrocardiograms occur, and the conditions which cause a number of the changes were described. Most of these conditions depend on changes within the structure of the heart, while others on the physical relation of the heart to the body of the individual. Finally, a number of observations indicating the value of the galvanometric method in studying the control of the central nervous system over the heart were presented.

The Kinetic System: George W. Crile.

Animals are transformers of energy. Adaptation to environment is made by means of a kinetic system of organs evolved for the purpose of converting potential energy into heat and motion. The principal organs comprising the kinetic system are the brain, the thyroid, the suprarenals, the liver and the muscles. The brain is the great central battery which drives the system, the thyroid governs the conditions favoring tissue oxidation; the adrenals govern immediate oxidation processes; the liver fabricates and stores glycogen; and the muscles are the final means by which the latent energy is converted into heat and motion. The positive evidence regarding the response made by these organs to various forms of stimulation contained in a large amount of experimental data is verified by the negative evidence that the power of the body to convert latent into kinetic energy is impaired or lost when the brain, the thyroid, the suprarenals, the liver or the muscles are impaired.

Clinical as well as experimental evidence shows that any change in any link of the kinetic chain modifies the entire kinetic system proportionately. Such a change may result in an immediate breakdown—acute shock; or else the gradual modification of one or more of the kinetic organs may give rise to a number of diseases. This theory has already given us the shockless operation and it opens a possibility of controlling certain chronic diseases which are the result of overstimulation of one or more of the organs in the kinetic chain.

The Hereditary Basis of Certain Emotional States: Charles B. Davenport.

Syriac Socrates—A Study in Syrian Philosophy: W. Romaine Newbold.

The speaker argued that this dialogue, which has been entirely neglected since its publication in 1858, represents a philosophical system so intimately related to that of Bardaisan of Edessa, that it must be regarded as written either by him or by some member of his school.

The Evolution of Pine Barren Plants: John W. Harshberger.

Segregation of "Unit Characters" in the Zygote of Œnothera with Twin and Triplet Hybrids in the First Generation: George Francis Atkinson.

The segregation of "unit characters" is a phenomenon now widely and well known, particularly as it relates to Mendelian segregation, with the production of different hybrid types in the second generation. But the segregation of several distinct hybrid types in the first generation of a cross between two species is a rare phenomenon. The fundamental distinction between these two types of segregation is apt not to be appreciated at once, since we are so accustomed to think in terms of Mendelian segregation.

Further, in Mendelian segregation, the production of "dihybrids," "trihybrids," etc., according to the number of contrasting allelomorphs in the parents, is so familiar that it requires some special emphasis for the mind to grasp how fundamentally different "twin hybrids" are from dihybrids, "triplets" from trihybrids, etc.

In the experimental studies here briefly outlined the two parents are *Œnothera nutans* and *Œ. pycnocarpa*, wild species of the evening primrose

in the vicinity of Ithaca, N. Y. They differ by more than thirty easily recognizable contrast pairs of "unit characters," or allelomorphic pairs, or, in terms of the "presence and absence" hypothesis, there are more than sixty "factors" of recognizable characters which meet in the fertilized egg of the cross between the two parents. These characters relate to the habit and color of the adults; features of the rosettes, foliage and inflorescence.

When *pycnocarpa* is the mother two distinct hybrid types are segregated in the first generation, and have been brought to maturity. These are *twin hybrids*. When *nutans* is the mother the same twin hybrids appear, and in addition a triplet which at present is in the rosette stage.

An analysis of the hybrids shows a distinct linking, or association, of certain characters. The bond between these characters is stronger than that of the total composition of either parent, and in the case of certain characters stronger than the total composition of certain organs or members. This results in a splitting of the total composition of both parents, and also a splitting of the total composition of certain members of the plant body. Examples of this linking of characters are as follows: First, habit characters; second, color characters; third, petal characters; fourth, broadness and toothedness of rosette leaves; fifth, narrowness and cutness of rosette leaves; sixth, crinkledness, convexity and red-veinedness of rosette leaves; seventh, plainness, furrowedness and white-veinedness of rosette leaves.

This splitting of the parental constitution resulting in the segregation into twin and triplet hybrids in the first generation occurs in the zygote or fertilized egg. Therefore it is of a very different type from that which takes place in Mendelian segregation due, according to general belief, to a qualitative, or differential division or reaction, in the gonotokonts (mother cells of the pollen grains and embryo sac). No such qualitative division is known to take place regularly in the fertilized egg. Therefore the usual karyokinetic process in the first division of the zygote can not be invoked in an interpretation of segregation of "unit characters" in the fertilized egg. The following hypotheses are considered.

First. De Vries's hypothesis of twin hybrids from mutating species. It does not appear probable, in the case of the two species considered here, that the segregation is due to the mutating character of one parent with its consequent splitability of constitution, combined with the splitting power of the constitution of another non-mutating parent, which is de Vries's interpretation of twin hybrids in the first generation of a cross between *Œ. lamarckiana*, or certain of its mutants, and a wild non-mutating species.

Second. Theory of a differential division in the zygote. The meeting, in the fertilized egg, of such a large number of homologous, but contrasting, "qualities" or "bearers," may be less favorable for a blending of the contrasting members of a pair, than for some other combination. The different positions which the linked "factors" or "qualities" occupy as they approach the nuclear plate of the first division may well be due in a large measure to chance. In this way different combinations might establish a working relation in different eggs. The material representing the groups of characters not entering into any one working combination may then be left behind in the first suspensor cell of the embryo, or cast out into the cytoplasm. The material in the first suspensor cell plays no part in the formative processes of the new individual, since this cell is side-tracked by the basal wall formed during the first division of the zygote.

Third. The reaction theory. In view of the fact, which seems to be now quite well established, that certain hereditary qualities are governed by enzymatic action, it may not be improbable that all the factors, or bearers, may work through enzymatic or catalytic or other chemical processes. But when the substances mixed are alike in all cases, and the conditions are the same, it is not intelligible, from a chemical point of view, why in some eggs one reaction should take place, while in others the reactions should be totally different. Even if we accept in principle the reaction theory, the different reactions taking place in different hybrid eggs seem to point to a differential division or segregation of material portions or regions of the hybrid egg cell.

The Vegetation of the Sargasso Sea: WILLIAM G. FARLOW.

The Sargasso Sea through which Columbus passed on his first voyage to America is characterized by the scattered masses of gulf weed which float on the surface of the ocean in patches generally from fifty to a hundred feet in diameter. The question as to the origin of the gulf weed has never been definitely settled. Some consider that the gulf weed whose botanical name is *Sargassum bacciferum* is merely a mass of sterile branches of some species of *Sargassum* which grows attached in the region of the West Indies

and fruits. Others believe that in its present floating form the gulf-weed is a distinct species which has lost the power of fruiting and increases only by offshoots. In recent years the species of *Sargassum* growing in different parts of the West Indies have been more carefully studied and a comparison with the floating gulf-weed shows that mixed with the latter are found in small quantity fragments of at least two species known to grow in the West Indies. In only one instance has there been found mixed with the gulf-weed a seaweed which must have come not from the American coast, but from Africa or southern Europe.

In spite of the fact that most recent writers consider the gulf-weed as a distinct species, there is reason to think that it is really derived from some *Sargassum* growing in the West Indies, fragments of which are carried by the Gulf Stream to the Sargasso Sea. There are, however, still many doubtful points to be settled.

THURSDAY EVENING, APRIL 23

Meeting of the Officers and Council
At 8:30 O'clock

FRIDAY, APRIL 24

Executive Session—9:30 o'clock

Proceeding of the officers and council submitted.

Morning Session—9:35 o'clock

Albert A. Michelson, Ph.D., Sc.D., LL.D., F.R.S., Vice-president, in the chair.

Phase Changes Produced by High Pressures: PERCY W. BRIDGMAN. (Introduced by Professor Goodspeed.)

The packing and the form of apparatus were described with which it has been possible to reach high pressures. These pressures have been pushed as high as 30,000 or 40,000 kgm. per sq. cm., or 15 or 20 times as high as that in modern artillery. The methods were then described by which it is possible to tell when a liquid is frozen to a solid or one solid changed into another by the application of pressure. One of the problems of particular interest is as to the character of the melting curve. There have been theories proposed, but hitherto sufficient pressure has not been obtainable to submit these theories to experimental test. Examination of the melting of a number of liquids over a wide pressure range has shown that the theories hitherto proposed do not hold at high pressures. The fact seems to be that as far as we can judge the melting curve continues to rise indefinitely, so that a liquid may be frozen by the application of sufficient pressure, no matter how high the temperature. A number of results are also obtained for the reversible transition from one crystalline form to another. Several new solid forms have been obtained; of particular interest are the new forms of ice, which are denser than water. In addition to these changes, which are completely reversible, one example has been found of an irreversible reaction produced by high pressure; yellow phosphorus may be changed by 12,000 kgm. and 200° to a modification in appearance like graphite, which is 15 per cent. more dense than the densest red phosphorus.

The Influence of Atmospheric Pressure on the Forced Convection of Heat from Thin Electric Conducting Wires: ARTHUR E. KENNELLY.

Some New Tests of Quantum Theory and a Direct Determination of "h": ROBERT ANDREWS MILLIKAN. (Introduced by Professor Goodspeed.)

It has been known for 25 years that when light of sufficiently short wave-length, *i. e.*, of sufficiently high frequency, falls upon a metal, it has the power of ejecting electrons from that metal.

It has been known for seven years that the kinetic energy possessed by the electrons thus ejected is larger the higher the frequency of the light which ejects them. In other words, blue light throws out electrons with greater speed than does red light.

Whether or not the energy of ejection is directly proportionate to frequency has been a matter of some uncertainty and of considerable dispute up to the present time.

The work herewith presented furnishes in the first place the most conclusive proof which has yet been found that there is exact proportionality between the energy of the ejected electrons and the frequency of the light which ejects them.

The second and most important contribution which it makes is the proof, given here for the first time, that the factor of proportionality between the energy of the ejected electrons and the frequency of the incident light is exactly the same quantity which has figured so largely in the recent developments of theoretical physics, namely, the fundamental constant which appears in Planck's theory of the discontinuous or explosive character of all radiant energy of the electromagnetic type. This constant is known as Planck's "*h*" and its value is directly deter-

mined in this work with an error which does not exceed one per cent. The value found is in very close agreement with that obtained by other methods. It is probable, however, that none of these other methods are capable of as high a precision as the photo-electric method here used.

The discovery that an electron ejected from a body under the influence of mono-chromatic light acts as though the whole energy content of the light wave were transferred without loss to the electron has important bearing on the whole framework of theoretical physics. It constitutes a new triumph of Planck's atomistic theory of radiation or, better, perhaps, a new proof of the usefulness in a new domain of Planck's "h."

The full theoretical significance of the mass of facts connected with "h" which have come to light within the past three or four years has not, however, as yet been fully discerned.

Discussion of "A Kinetic Theory of Gravitation"—(1) Gravitation is Due to Intrinsic Energy of the Ether; (2) Transmission of Gravitation can not be Instantaneous: CHARLES F. BRUSH.

A kinetic theory of gravitation was outlined by the author at the Minneapolis meeting of The American Association for the Advancement of Science,[1] in which the ether is assumed to be endowed with vast intrinsic kinetic energy in wave form of some sort capable of motive action on particles, atoms or molecules of matter, and propagated in every conceivable direction so that the wave energy is isotropic. Particles or atoms are imagined to be continually buffeted in all directions by the ether waves like particles of a precipitate suspended in turbulent water. There are no collisions because neighboring particles follow very nearly parallel paths. Each atom or particle is regarded as a center of activity due to its energy of translation initially derived from the ether; whereby it has a field of influence extending in all directions, or casts a spherical energy shadow, so to speak. The energy shadow of a body of matter is the sum of the shadows of its constituent parts. The energy shadows of two gravitating bodies interblend, so that the energy density between them is less than elsewhere, and they are pushed toward each other by the superior energy density or wave pressure, on the sides turned away from each other.

In the present discussion the author employs some impressive illustrations to show that the energy acquired by falling bodies has some *external* source, and that it must be ethereal energy or energy of space; and he holds that the term "potential energy of position," as applied to a system of gravitating bodies implies the energy-endowed ether as a necessary part of the system.

[1] SCIENCE, March 10, 1911; *Nature*, March 23, 1911.

As a corollary, the author explains how bodies falling toward each other by reason of their mutual attraction, and thus *accelerating*, that is to say, absorbing energy from the ether, can not rigidly obey Newton's law of inverse squares of distance. The force of attraction instead of varying as $1/D^2$, as it does for bodies at rest or in uniform motion, varies as $1D^{(2-x)}$ for bodies accelerating in the line of attraction, wherein x is a very small quantity which appears to vary with the rate of energy transformation or velocity of fall. When acceleration is negative, that is to say when energy transformation is *from* the accelerating body *to* the ether, x becomes positive.

In the case of a planet of the solar system, x obviously increases in importance with eccentricity of orbit, and may become appreciable in the highly excentric orbit of Mercury. The author expresses the hope that this alternately plus and minus deviation from Newton's law will be found adequate to explain the secular advance of the perihelion of Mercury's orbit. He also calls attention to the fact that the moon moves toward and away from the sun almost the whole diameter of her orbit every month, and hopes that, in this connection, the deviation from Newton's law above indicated may explain the outstanding lunar perturbations, and perhaps cancel another to be mentioned later.

In the second division of the paper the author describes the premises from which Laplace drew his famous conclusion that gravitation is transmitted with infinite, or virtually infinite, velocity; a dogma which "for more than a century has blocked the path of fruitful thought on the physics of gravitation." The radically different premises growing out of the theory under discussion are then described and contrasted with those of Laplace, to explain why and how the author reaches such a widely different conclusion. He concludes that, even if the velocity of transmission is no greater than that of light, the moon's mean motion will be *retarded* a very few seconds of arc only, in a century; and the retardation will be correspondingly less if the velocity is greater than that of light. This retardation, of course, adds to the unexplained acceleration, if any, of the moon's motion; but the author further hopes that this retardation, plus the outstanding acceleration,

will be explained by the deviation from Newton's law already described.

Behavior of Metals and Other Substances under Stress Near the Rupture Point: A. A. MICHELSON.

On Highly Radioactive Solutions: WILLIAM DUANE. (Introduced by Professor Goodspeed.)

At the annual meeting last year the author spoke on "Some Unsolved Problems in Radioactivity." At that time he stated that a number of superficial cancers had been cured (some of them only temporarily) by the proper application of a sufficient quantity of radium, but that the problem of treating internal cancers had not been satisfactorily solved. There appears, he said, to-day to be no reason for changing that statement.

Since that meeting the Cancer Commission of Harvard University has purchased about 250 milligrams of radium element, and has been investigating the effects due to the rays from radioactive substances on tissues, using methods that the author has devised and that are somewhat different from those employed before. He dwelt particularly on one of these methods, namely, that in which a concentrated radioactive solution is injected into the tissues.

Before describing the experiments he recalled the following well-known facts. Firstly: radium is continually transforming itself into a gas called radium emanation, and this emanation is continually transforming itself in turn into a succession of substances called radium A, B, C, etc., which are grouped together under the general term "deposited activity." These substances are radioactive as well as the radium itself. Any sealed glass tube containing radium contains these other radioactive substances also.

Secondly: these substances emit three types of rays, the alpha, beta and gamma rays. The alpha rays carry with them about 90 per cent. of the energy of the radiation, and the other 10 per cent. is divided between the beta and gamma rays. The alpha rays, however, are the least penetrating of the three types; they are stopped by about 1/25 of an inch of ordinary flesh.

Thirdly: radium, the emanation and radium A practically emit alpha rays only. Radium B emits weak beta and gamma rays and no alpha rays; but radium C emits all three kinds and is by far the most powerful radiator of the whole group. In the ordinary application of radium to tumors the methods are of such a nature that the alpha rays are absorbed before they reach the tissues, and the beta and gamma rays, therefore, are the only ones used. Hence over 90 per cent. of the energy is wasted; and further the rays that are used come exclusively from radium B and C, and not from the radium itself or from the emanation.

The emanation and deposited activity can be separated from the radium and used alone. The method the author has perfected for doing this is as follows: The radium salt itself is in solution in a small glass tube, from which the air has been completely exhausted. Under these circumstances the emanation escapes from the solution. A simple mercury pump pumps the emanation into a second tube containing phosphor pentoxyd and a copper wire heated red hot by an electric current. The hot wire absorbs the hydrogen and oxygen that have been produced by the decomposition of the water, and the pentoxyd absorbs the water vapor. After purification a second pump pumps the emanation into a small glass bulb containing a few grains of common salt. The emanation remains in contact with the salt for several hours, depositing radium A B C on it. The salt thus becomes very radioactive, and on being removed from the bulb and dissolved in a small amount of water carries with it the activity, thus making the solution itself radioactive.

He has used several other methods of making these radioactive solutions. The deposited activity may be deposited on sodium hydroxide, and this may be dissolved in a few drops of water containing just enough hydrochloric acid to neutralize the hydroxide; or the emanation may be sealed into a small glass bulb with a capillary glass tube attached. If this is placed under water or a saline solution and the capillary tube broken, the liquid runs up into the bulb and dissolves the emanation, forming a radioactive solution. Solutions made by these methods may be millions of times more active than those hitherto used. In fact, they may be made weight for weight far more active than any solution containing radium itself could be.

The advantage in using these solutions in studying the effects produced on tissues is that after injection the radioactive substances come into intimate contact with the tissues, and thus the full power of the alpha rays is utilized.

If a solution of radium itself is injected, the process is not only costly, but very dangerous on account of the long life of the radium. The deposited activity solutions do not have these objections, for the radium is not wasted in producing the solutions and the activity lasts for only a short time.

He made a number of experiments to find out

where the radium A B C goes to after the injection. The injection is absolutely painless. If the injection is made subcutaneously a large fraction of the activity remains in the neighborhood of the point of injection, and the rest is carried off in the lymph and blood streams. The rapidity with which the activity gets into circulation is astonishing. A drop of blood taken from another part of the body only a few seconds after the injection is more radioactive than carnotite or pitchblende ores. It would seem that this might prove to be a delicate method of studying the flow of fluid through the tissues.

On making tests by means of the gamma rays an hour or an hour and a half after the injection he found that there was very little activity in the brain and lungs, but that there was a tendency for the substances to deposit out in the liver, spleen and kidneys.

Histological examinations were made by Dr. E. E. Tyzzer, who found a marked destruction of the bone marrow and of the leucocytes. Further, if the injection is made either into the tumor or the veins of a mouse with a tumor there is a decided destruction of the tumor cells.

Some Further Considerations in the Development of the Electron Conception of Valence: K. G. FALK. (Introduced by Professor Bogert.)

The Valence of Nitrogen in Ammonium Salts: WILLIAM ALBERT NOYES. (Introduced by Professor H. C. Jones.)

The specific rotation of solutions of aminocamphonanic and of aminodihydrocampholytic acids have been determined, also the rotations of the anhydrides, hydrochlorides and sodium salts of these acids. A comparison of these rotations furnishes strong evidence that the free aminocamphonanic and the aminodihydrocampholytic acids exist in the form of cyclic salts, containing a ring of six atoms and nitrogen in the quinquivalent form. The α-aminocampholic and β-aminocampholic acids, on the other hand, as indicated by the rotation of their solutions, do not form such cyclic salts, probably because the salts, if formed, would contain a seven-atom ring. The study of these compounds furnishes considerable evidence that nitrogen is in reality quinquivalent in ammonium salts and that such salts are not merely addition compounds formed by the union of the acid with the amino compound in such a manner that each molecule retains its original structure.

Determination of the True Atomic Weight of Radium: GUSTAVUS HINRICHS.

FRIDAY, APRIL 24

Afternoon Session—2 o'clock

Edward C. Pickering, D.Sc., LL.D., F.R.S., Vice-president, in the chair.

Presentation of a portrait of the late Samuel Pierpont Langley, LL.D., a former vice-president of the society, by Cyrus Adler, A.M., Ph.D., on behalf of a number of members of the society.

The Magnetic Phenomena of Sun-spots; The General Magnetic Field of the Sun: GEORGE E. HALE. (Illustrated with lantern slides.)

Summary of Researches, Department of Terrestrial Magnetism, 1904–14: LOUIS A. BAUER. (Illustrated.)

On the Colors of the Stars in the Cluster M 13: EDWARD E. BARNARD.

The Use of a Photographic Doublet in Cataloguing the Position of Stars: FRANK SCHLESINGER.

The Distribution in Space of 90 Eclipsing Stars: HENRY NORRIS RUSSELL.

The Eclipsing Variable Stars ψ Oriones and 88 d Tauri: HARLOW SHAPLEY. (Introduced by Professor H. N. Russell.)

Some Features of Moon's Motion and a Problem in Isostasy: ERNEST W. BROWN.

The United States as a Factor in World Politics: LEO S. ROWE.

After an analysis of the circumstances that have made the United States an important factor in world politics, Dr. Rowe proceeded to discuss the lack of adjustment between the international position of the United States and the national thought of the American people. The country has advanced to the rank of a world power, but the standards of public opinion with reference to international affairs have failed to make a corresponding advance. In discussing the situation, the speaker said:

We are at the present moment witnessing one of the most serious consequences of this lack of adjustment which is affecting the international position and influence of the United States to a degree which can not help but arouse the grave concern of every thoughtful and patriotic citizen. In a brief period of fifteen years we seem to have sacrificed the position of leadership in the maintenance of world peace, and have become one of the disturbing factors in world politics. How is it, it will be asked, that a nation which through the contributions of more than a century has gained an enviable position as a leader in the great movement for the advancement of international good-will, a nation whose founders dreamed of a period of uni-

versal peace, should within so short a space of time sacrifice this enviable position and come to be looked upon by all nations of western civilization as an uncertain factor in the orderly development of international relations?

Every student of international law and of world politics has been deeply impressed by the important part played by the United States, in placing the conduct of international relations on a distinctly higher plane. It seems, at first glance, extraordinary that during the first half century of its national existence a nation so weak and in many respects so unorganized should have been able to exert so important an influence on international law. When, however, we stop to reflect that during the first decades of the nineteenth century the United States held the balance of power, the apparent paradox is really explained.

The far-seeing statesmanship of the founders of the republic led to the adoption, as a cardinal principle of American foreign policy, of the rule that the United States must be kept free not merely from entangling European alliances, but from any participation in the conflicts then raging in Europe. This principle of aloofness from European entanglements led to the assertion of those principles of American neutrality which, while serving primarily the interests of our national integrity, accomplished the still larger purpose of laying the foundations for the modern law of neutrality, which has done so much toward eliminating the causes of international irritation and, therefore, of promoting the interests of world peace.

It has been the laudable ambition of successive Secretaries of State to continue and to strengthen those lofty and noble traditions which gave to the country a position of such unique power amongst the nations of both eastern and western civilization. In spite of these efforts, however, there is noticeable, during recent years, a distinct falling off in our international prestige. Little by little, the confidence of the peoples of Europe and of the American continent has been undermined until today we find ourselves in a situation which possesses none of the elements of that splendid isolation which so long characterized the position of Great Britain and which, if not remedied, is likely to deprive us of the possibility of continuing a mission which constitutes the chief glory of American foreign policy during the first century of our national existence. It is, therefore, a matter of real national moment to inquire into the causes that have brought about this change, and to seek a remedy, if such exists.

Of the elements contributing to the present situation, some are of long standing, the cumulative effects of which are now being felt, while others are of comparatively recent development. Amidst the splendid record of achievement during the first century of our national existence there looms up one aspect in our policy which has been a source of deep concern to successive Presidents and to successive Secretaries of State. I refer to the inadequacy of our national legislation for the protection of aliens resident within our borders. A long series of massacres, beginning with the Chinese massacre at Rock Springs, Wyoming, in 1895 and ending with the lynching of Italians in 1899, 1901 and 1910, have placed our national government in the humiliating position of acknowledging to foreign powers that although the sole responsibility for the conduct of our foreign relations rests with the federal authorities, they lack the power to fulfill that primary and fundamental international obligation, namely, that the persons responsible for such crimes shall be brought to justice.

It is clear that no nation can shirk the responsibilities of its international obligations without arousing widespread opposition. The constitutional authority granted to our federal government is sufficiently broad and comprehensive to include all powers necessary to meet our international obligations. We can not permit our states, which occupy no international status, to plunge us into irritating controversies with foreign countries. The dignity of the national government and the demands of national self-respect require that the federal executive be given statutory powers and that the federal judiciary be given jurisdictional authority sufficiently broad to enable the national government to do its full duty in the protection of the persons and property of aliens resident within our borders. The first step in this direction is the enactment of a law giving the federal courts jurisdiction over all cases in which the treaty rights of a citizen or subject of a foreign country are involved. A bill to this effect has been before the congress of the United States on several different occasions.

The remedy for this situation is so simple that there is no excuse for further delay in making it effective.

A second influence which has played an important part in estranging the good-will of foreign countries is the widespread belief that there exists in the congress of the United States a marked tendency to force upon the executive a narrow and technical interpretation of treaties. Secretary Hay once said of certain senators who attempted to defeat every treaty presented to the senate that their idea of a treaty was a document which gained everything for the United States and gave nothing to the other party. The ruthless way in which the congress of the United States has at times swept aside treaty obligations, and the unwillingness to bring national legislative policy into harmony with our international obligations have created the impression that the promises of the United States can not be depended upon, and that even the best intentions of the President and his advisers are apt to be thwarted by the action of congress.

The culminating point of a series of instances was reached in the provision of the Panama Canal Act exempting American coastwise shipping from the payment of Canal tolls. Whatever may be our views as to the desirability of the exemption clause viewed as a question of domestic policy, it is clear from the history of the Clayton-Bulwer and of the Hay-Pauncefote treaty and from the testimony of those who assisted in the negotiation of the latter that the United States made no attempt to reserve to itself the right to give preferential treatment to its own merchant vessels. The privileges acquired

by the United States under the Hay-Pauncefote Treaty involved certain sacrifices on the part of Great Britain, for which she exacted the observance of the principle of equality of treatment. It would be a reflection on our country's reputation for fair dealing if, after securing the abrogation of the Clayton-Bulwer Treaty, we were to repudiate the concessions, the making of which rendered possible the ratification of the Hay-Pauncefote Treaty.

Fortunately for the good name of the United States, the President has courageously taken a position, which has not only aroused the admiration of the civilized world, but has placed our country under a debt of obligation. In his address of March 5, 1914, to the congress of the United States, he sounded a note which served to impress upon the nation the sacredness of treaty obligations.

The magnitude of the President's service goes far beyond the vindication of the Hay-Pauncefote Treaty. These words and the determination which lies back of them place the international relations of the United States on a distinctly higher plane, and, if properly supported by the united opinion of the country, will do much toward regaining for the United States the enviable position which we once occupied. All secondary and party interests must be made to bow before that higher standard of international dealing which the President so vigorously champions.

Passamaquoddy Morphology: J. DYNELEY PRINCE.

The present article on the morphology of the Passamaquoddy language of Maine is the first result of the rehabilitation of my exhaustive treatise on the Maine Passamaquoddies which was destroyed by fire, together with all notes, in 1911. The Passamaquoddies of Maine, as well as their close congeners, the Milicetes of New Brunswick, are second to the Micmacs in numerical importance among the eastern Algonquin tribes. The Micmacs of Nova Scotia, the Passamaquoddy-Milicetes of Maine and New Brunswick, and the Penobscot-Abenakis of Maine and Quebec constitute the family of the Wabanaki "people of the dawn-land" whose extraordinary folklore and interesting linguistic structure have been strangely neglected. In the paper especial attention was paid to the verbal formation of the Passamaquoddy with a comparison between its forms and those of the Abenaki of Canada, and in his oral presentation of this subject Professor Prince gave a few brief specimens of eastern Algonquin folklore poems in order to illustrate the character of these Indians.

A Sumerian Nature Hymn from Nippur, of the Time of the Dynasty of Agade, 2800–2600 B.C.: GEORGE A. BARTON.

This cylinder was found at Nippur by Dr. Haynes and, after its arrival in Philadelphia, remained until recently unpacked in the basement of the University Museum. The cylinder was originally six and one half inches long and approximately four and one half inches in diameter. It was inscribed with nineteen columns of writing, each slightly less than three fourths of an inch wide. One side of the cylinder, to the width of eight columns of writing, is broken away, but seven fragments of this portion have been found in the packing-boxes. From these fragments it has been possible to recover a portion of each of the columns of writing. On account of the crumbling of the clay, parts of some of the columns on the main portion of the cylinder are illegible. The script of the inscription is that of the dynasty of Agade, 2800–2600 B.C. The language is pure Sumerian. From the frequent references to a "foundation" in the text, it is probable that this was a foundation cylinder. Similarly the frequent references to sickness make it probable that a plague had recently visited Nippur. Parts of the text remind one of the incantations of later times; in parts there are beautiful descriptions of nature.

The name of the rebuilder of the temple and the author of the inscription have been broken away. The following are samples of its text:

The lord of darkness guards man;
The lord of light guards man;
The lord of life guards man;
The lord of the sanctuary guards man;
The grain for thy animals he increases;
God favors man.

The following extract shows that the Nippurians were not strangers to the charms of the flowing bowl:

The eye of wine presents 36,000 openings,
The bright eye is very brilliant,
Like the goddess, the great mother.
O our lady, mighty one, brilliant goddess,
Unspeakable is the splendor of thy vegetation!

The sickness is referred to in the following:

The fiery tablet of Enlil
To Nippur
Against the sickness he has brought;
With Ishtar of Erech for the protection of thy land from death
Against the sickness he has brought it;
With Ea thy chief,
Against the sickness he has brought
The fiery tablet of Enlil.

And again:

Enlil declares:
"Gone is the sickness from the face of the land."
As a protector he removed it—
Enlil's are they—
As a protector he removed it.

The last words that can be made out of the remaining text are:

He protects thee from death
And an evil fate.
This foundation Enzu laid,
Tappinu-grain he makes abundant,
Thy land he protects, he establishes for men.

FRIDAY EVENING, APRIL 24

Reception from 8 to 11 o'clock

at

Hall of the Historical Society of Pennsylvania, S. W. Corner of Locust and Thirteenth Streets

Arthur L. Day, Ph.D., director of the geophysical laboratory of the Carnegie Institution of Washington, gave an illustrated lecture on "Some Observations of the Volcano Kilauea in Action," at 8:15 P.M.

SATURDAY, APRIL 25

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership balloted for.

Morning Session—10 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the chair.

Primary Cambrian Manganese Deposits of Newfoundland: NELSON C. DALE. (Introduced by Professor W. B. Scott.)

Geology of the Wabana Iron Ores of Newfoundland: ALBERT O. HAYES. (Introduced by Professor W. B. Scott.)

Hewettite, Metahewettite and Pascoite, Hydrous Calcium Vanadates: W. F. HILLEBRAND.

The Relations of Isostasy to a Zone of Weakness—the Asthenosphere: JOSEPH BARRELL. (Introduced by Professor Charles Schuchert.)

The mass of every mountain or mountain range tends to deflect the plumb-line toward it and slightly away from the true vertical, so that the measured latitude and longitude of any locality will differ slightly according as it is determined by triangulation from other regions or by independent astronomic determination of the point in which the observed vertical pierces the celestial sphere. But Hayford has shown that the deflections of the vertical are actually only one tenth of the deflections calculated as due to the terrestrial relief. This is a quantitative test of the degree of isostasy and shows that the continents stand high above the ocean floors because they are underlaid with lighter matter. Such a relation of density to relief explains the almost complete neutralization of the gravitative effect of the relief and accounts for the smallness of the observed deflections of the vertical, averaging for stations in the United States only about three seconds of arc. Dynamically it implies a state of flotation of the crust upon the inner earth analogous to the flotation of an iceberg in the ocean.

Yet the earth as a whole is known to be about as rigid as steel; the nature of earthquake vibrations transmitted through the earth shows it to be solid throughout and more incompressible and rigid at great depths than near the surface. Within the limited range of temperatures and pressures open to experiment Adams has added to the evidence and shown that rocks possess greatly increased strength under cubic compression. Furthermore, the writer has published recently some calculations which show that the loads supported by the strength of the crust are much greater than had been generally supposed. The delta built out by the Niger River, for example, is equivalent in mass to at least 2,000 feet of rock above sea-level, extending over a circular area not less than 300 miles in diameter.

How then shall the geodetic evidence pointing toward a general flotation of the crust near to equilibrium be reconciled with this other evidence of great rigidity and strength? It has long been supposed that a mobile zone may explain the apparent contradiction, but the necessity of postulating such a zone becomes greater as the accumulated evidence of weakness, on the one hand, of strength, on the other, diverges more and more. It is the consideration of the depth and physical nature of this zone which is the thesis of the present paper.

By means of a study of the area of the surface loads and their degree of departure from isostatic equilibrium this zone is located far deeper than other estimates have placed it; the level of minimum strength being thought to lie as much as 150 to 200 miles deep. The maximum strength is probably at a depth of 10 to 20 miles and falls off rapidly below. At great depths the earth is doubtless again much stronger and resists deforming stresses as would a globe of steel. In physical character this zone of weakness is thought to possess high elasticity, but, under prolonged stresses, a low elastic limit. This shell of the earth plays such an important part in geologic dynamics that it is thought to merit a special name—the sphere of weakness—the asthenosphere.

Evidence for a Pulsational Change of Climate in the Libyan Desert: WILLIAM H. HOBBS.

The Cretaceous-Tertiary Boundary in the Rocky Mountain Region: F. H. KNOWLTON. (Introduced by Professor John M. Clarke.)

As a result of certain stratigraphic and paleobotanical work in the Rocky Mountain region, Mr. Knowlton became convinced some years ago that the then accepted boundary line between Cretaceous and Tertiary would require readjustment to bring it in harmony with ascertained facts. Evidence bearing on this point has been cumulative, and as a final result he feels justified in presenting and defending the following thesis: The dinosaur-bearing beds known as the Ceratops beds, Lance Creek beds, Lance formation, Hell Creek beds, Somber beds, Lower Fort Union, Laramie of many writers, Upper Laramie, Arapahoe, Denver, Dawson, and their equivalents, are above a major time break and are Tertiary in age. Stratigraphic, diastrophic and paleontologic evidence in support of this contention were presented.

The Geologic and Biologic Results of a Study of the Tertiary Floras of Southeastern North America: EDWARD W. BERRY. (Introduced by Professor William B. Clarke.)

The results of several years of study of the exceedingly rich Tertiary floras of southeastern North America were announced for the first time. Their botanical relationships and their bearing on the evolution of types and upon geographical distribution were summarized. The geological results include the recognition of hitherto unknown intervals during which many thousands of square miles were above sea-level. These studies have also afforded for the first time fossil floras of fixed stratigraphic position for comparison with the floras of the Rocky Mountain Province on the border between the Cretaceous and the Tertiary whose age has been the occasion of several decades of controversy. They also afford means for correlation with the type section of the Paris basin, and likewise furnish a large body of evidence bearing upon geological climates and other physical features of the past.

The Burgess Shale Fauna of the Canadian Rockies: CHARLES D. WALCOTT.

On Multiple Treatment of One and the Same Story "Motif": MAURICE BLOOMFIELD.

Some Biblical Miracles: PAUL HAUPT.

The Sumerian Pronunciation of the Name "Ninib" as the Chief Deity of Umma: ALFRED T. CLAY.

Panama Tolls and Tonnage Rules: EMORY R. JOHNSON.

SATURDAY, APRIL 25

Afternoon Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the chair.

Unveiling of a medallion portrait of the late Sir Joseph Dalton Hooker, O.M., G.C.S.I., C.B., by William G. Farlow.

Symposium on Physics and Chemistry of Protoplasm—

The Germ Plasm as a Stereochemic System: EDWARD T. REICHERT. (Introduced by Dr. Keen.)

Arrangement and Distribution of Substances in the Cell: EDWIN GRANT CONKLIN.

Vital Staining of Protoplasm: HERBERT McLEAN EVANS. (Introduced by Professor Piersol.)

Protoplasm does not exist as a substance, but only as an organism; it is never found in the mass, but only in the form of cells. Even the simplest cells are complex structures consisting of many parts. In practically all cells there is a central portion, the nucleus, which is sharply marked off from the surrounding portion or cell body. Each of these portions is further subdivided into different parts or substances; the most constant differentiations of the nucleus are chromatin and achromatin, of the cell body cytoplasm and metaplasm. Other differentiations which are frequently present are centrosomes or division centers, with surrounding archiplasm, cell membranes, cortical layer of cytoplasm, central cytoplasm and perinuclear plasm.

The relative positions of different cell constituents vary in different kinds of cells, and in the same cell at different phases of cell life or under different environmental conditions. In cells which are not dividing the nucleus usually lies near the center of the cytoplasm, though it may be eccentric toward the side on which nutriment is received and away from the free border of epithelial cells. The centrosome usually lies at the pole opposite the nucleus and toward the free border of epithelial cells. The chief cell axis is the line connecting centrosome and nucleus. Thus many cells have a definite polarity.

In some plant and animal cells the contents circulate in a more or less definite manner; this is called cyclosis. In dividing cells the movements of cell contents are most marked, the movements taking place largely around the centrosomes which serve as centers of diffusion currents. These diffusion currents start at the time when the sub-

stance of the nucleus begins to mingle with that of the cell and they not only distribute the cell contents in a definite way, thus causing differential or non-differential division, but they also probably cause the separation of the chromosomes and the division of the cell body.

When a spermatozoon enters the cortical layer of an egg, or when this cortical layer is pricked by a needle, the substance of this layer flows rapidly to the point of entrance, where it forms an entrance cone, while the sperm head with some of the cortical substance penetrates to the interior, and the egg and sperm nuclei then approach one another. Then the cell movements connected with the first cleavage begin and the egg substances become segregated and localized by means of these currents into areas which give rise to particular organs. Since the pattern of this localization is different in different groups of animals, it must be that there is an internal regulating mechanism which determines the direction and extent of the movements within the cell.

Finally the relative sizes, positions and order of appearance of different parts of a cell during division, or of an egg during the early stages of development, are indicative of certain generic relations between these parts. The centrosome and archiplasm are thus found to be causally connected with the achromatin of the nucleus; the chromatin grows at the expense of the achromatin; and the cell body influences the growth of the nucleus, while the nucleus influences the differentiations taking place in the cell body.

All of these complicated morphological and physiological phenomena are doubtless the expression of chemical and physical processes occurring in the cell; a few of these processes may now be indicated, but that which is known is as nothing compared with what remains to be learned about the physics and chemistry of the cell.

The Physical State of Protoplasm: G. L. Kite. (Introduced by Professor McClung.)

An accurate knowledge of the physical state or conditions of living matter has been gained for the first time by the employment of new methods for the dissection of living cells under the highest power of the microscope. Most living matter has been definitely proved to be in the jelly state. In a few kinds of cells the living substance is a liquid. Micro-dissections have thrown new light on the distribution of jellies and liquid in living cells and proved for all time the physical reality of such important structures as chromosomes, nucleoli and spindles.

The Physico-chemical Organization of the Cell: Lawrence J. Henderson. (Introduced by Dr. H. F. Keller.)

At the banquet on Saturday evening at the Bellevue-Stratford about eighty members and guests were present, the toasts being responded to as follows:

"The Memory of Franklin," by Hon. Mayer Sultzberger.

"Our Institutions of Learning," by Professor J. Dyneley Prince.

"Our Guests," by Professor Maurice Bloomfield and Sir Ernest Rutherford.

"The American Philosophical Society," by Russell Duane.

Arthur Willis Goodspeed

Philadelphia,
May 4, 1914

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 525th regular meeting was held April 4, 1914, in the assembly hall of the Cosmos Club, with Vice-president Dr. W. P. Hay in the chair, and 35 persons present.

Wm. Palmer gave the first paper on the regular program: "Notes on the Hatching of a Local Terrapin (*Kinosternon pennsylvanicum*)." From 4 to 5 eggs are found in nests of this turtle. The contents of one were transferred to the yard of Mr. Palmer's house in Georgetown, and apparently hatched, only after a lapse of 13 months. Mr. A. A. Doolittle and the chairman discussed the paper, the latter remarking that the diamond-back terrapin presents a similar case. The eggs are laid in the spring, and although hatched in the fall, the young sometimes remain in the nests until the following spring.

The second paper by Dr. O. P. Hay, was "An Account of a Visit to Some of the Smaller Museums." On a recent trip the speaker had visited some 40 towns for the purpose of examining specimens of Pleistocene vertebrates. He gave an account of the size and character of the collections in various towns and remarked upon the conditions under which the fossils were deposited. At Mount Union Scio College, Ohio, was seen a skull of the giant beaver, which was 13 inches long, the largest known. At Norwalk, Ohio, was found a specimen of the ground sloth (*Megalonyx*), which establishes the fact that these animals existed after the retreat of the last ice sheet. At Kansas City, Kansas, is the head of a whalebone whale, said to have been found in Oklahoma. It is undoubtedly modern, and the datum erroneous. The

most general fault with the small museums is the lack of labeling, particularly as to locality.

Dr. J. O. Snyder then presented the last paper of the program, entitled, "The Fishes of the Lahontan Basin, Nevada, their Habits and their Relation to the Geology of the Region." Dr. Snyder stated that his communication was a synopsis of the results of a scientific and practical investigation for the Bureau of Fisheries, of the following lakes and their tributaries, Eagle, Hono, Tahoe, Pyramid, Winnemucca, Carson and Walker, representing at least five distinct systems.

The fish fauna includes the following genera: *Catostomus*, *Leuciscus*, *Rutilus*, *Chasmistes*, *Salino*, *Agosia*, *Cottus* and *Coregonus*. The speaker discussed all but the last three.

The minnows of the genus *Leuciscus* change color constantly as they become sexually mature, and this change in appearance has resulted in a multiplicity of names for a single species. These little fish follow the suckers and feed eagerly on their eggs.

Chasmistes, a fish practically unknown to science, since the original description was found to spawn in immense numbers in the Truckee River. They were so numerous as to crowd part of their number out on the sandbars where they died. Large quantities are caught and dried by the Piute Indians.

Trout are abundant in the Lahontan basin. They belong to three main groups, the brook trouts, the red-spotted, and the cut-throats, each with numerous races. The silver trouts of Pyramid and Winnemucca lakes are distinguished from those of Tahoe by color, but not otherwise. They ascend the streams to spawn, in two migrations, the individuals of the two schools differing considerably in appearance.

The royal silver trout, a new species recently found in Lake Tahoe, is remarkable in remaining unknown to science for so long. It has long been known to local fishermen, and their descriptions of its peculiarities were confirmed when Dr. Snyder received specimens. The species is regarded as a superior food fish, and for this reason has not reached the markets, being kept for home consumption.

The La Hontan Basin is surrounded by San Joaquin, Sacramento, Klamath, Columbia, Bonneville and Colorado systems, but is isolated from them. Geological evidence is to the effect that the basin has always been without outlet. So far as the fish fauna is concerned, *Chasmistes* points to a possible relationship with the Klamath and Bonneville systems, in both of which it is found.

This communication was discussed by Messrs. A. A. Doolittle, M. W. Lyon, Wm. Palmer and the speaker.

The 526th regular meeting was held April 18, 1914, in the lecture hall of the Cosmos Club, with Vice-president Dr. J. N. Rose in the chair and 40 persons present. Under the heading of brief notices, President Paul Bartsch commented on the absence of red-headed woodpeckers in the vicinity of Washington. Apparently none had wintered and it was thought migrants were overdue. Dr. M. W. Lyon gave similar testimony. Mr. Alex. Wetmore said the species was seen along the Patuxent River, Md., March 15, and that in his experience, when the red-head is not present in winter it does not return till late.

Titus Ulke then gave the first paper on the regular program, entitled, "Notes on Bermuda Birds." The speaker noted the large number of birds that have been recorded from the Bermudas, a large proportion of which are casual visitors. He then gave notes on the distribution, habits and local names of the following 18 species: Bermuda catbird, bluebird, northern water-thrush, Bermuda white-eyed vireo, European house-sparrow, Bermuda cardinal, belted kingfisher, pigeon hawk, Bermuda ground-dove, golden plover, jacksnipe, great blue heron, bittern, coot, black duck, blue-winged teal and European goldfinch. The paper was discussed by Messrs. T. W. Vaughn, Wm. Palmer, W. L. McAtee and the author.

T. Wayland Vaughn then delivered his communication on "Reactions of Corals to Food and to Non-nutrient Particles, and the Nature of the Food of Corals." He first gave a sketch of the structure of the coral polyp, in so far as it is related to prehension and assimilation of food. The entire ectoderm of the animal is armed with nematocysts for disabling living prey. It is further covered with mucus and is provided with cilia which waft food toward the mouth and rejected objects away. Experiments in feeding coral polyps were made with the following substances: bits of crab meat, cut-up minnow and beef juice. When solid food was placed on the oval disc, the tentacles expand, bend over, and pass food to mouth; the edges of the oval disc contract over the mouth until swallowing is completed. The impulse to expand the tentacles stimulated by a food particle is communicated from polyp to polyp until the whole colony is expanded.

Corals can be satiated with food, and when this condition is reached all objects are wafted away

from month. Corals free themselves from foreign objects, as sand. These are sometimes swallowed, but eventually all are rejected. Corals living where wave action is great have less power to cleanse themselves than species living on sand or mud-flats.

Corals sometimes swallow as large objects as small jellyfish and crabs. In experiments they took pieces of fish, crustacea and even pieces of other polyps. They ate also every kind of marine plankton, except Pycnogonida, which were rejected. Every copepod dropped on the oval disc of a coral or even on the column wall was killed and wafted to mouth. No vegetable matter of any kind was taken. Pure cultures of diatoms were invariably rejected; if dipped in beef juice diatoms were swallowed, but later ejected. Bits of seaweed were similarly treated. The conclusion is, therefore, that coral polyps are strictly carnivorous. The communication was discussed by Mr. A. A. Doolittle and the speaker.

Mr. A. A. Doolittle then gave the last paper of the program: "The Plankton Resources of Some Massachusetts Ponds." He spoke of the bearing plankton studies have on the broad problem of the conservation of natural resources. A study of the plankton is necessary to the utmost utilization of the fish resources, since practically all fishes, at some stage of their existence, feed on plankton, especially the entomostraca.

In the eight Massachusetts lakes studied, samples were taken from bottom to surface and in all parts of the lakes. Twenty-six species of Entomostraca were collected, one new. Copepods were much more numerous in individuals than the Cladocera, and composed from 50 to 75 per cent. of the total plankton. The number of plankton under a square yard of surface varied from seven thousand to eighty-two thousand. The largest numbers were found in the shallower lakes. The number per cubic yard of water varied from 500 to 17,500, the largest number by this estimate also in a shallow lake. In fact the number of plankton varies inversely as the depth, the deeper parts of quiet lakes having few or none.

Knowing the amount of plankton in a lake, if stomachs of fish are examined to determine the amount they consume, we can estimate the number of fishes the water may support. Mr. Doolittle's paper was discussed by Drs. C. D. Marsh and M. W. Lyon.

The 527th meeting was held May 2, 1914, in the lecture room of the Cosmos Club, with Vice-president Dr. W. P. Hay in the chair, and 46 persons present. Frederick M. Gaige, University of Michigan and Frederick C. Lincoln, Colorado Museum of Natural History, were elected to membership. It was announced that the 527th would be the last meeting of the season.

In response to the call for brief notes, W. L. McAtee compared the abundance of birds in the neighborhood of the District of Columbia, as stated in Coues's and Prentiss's lists of 1862 and 1883, with that of the present. Discussion followed by Wm. Palmer and W. W. Cooke.

Calling Dr. M. W. Lyon to the chair, Dr. W. P. Hay gave the first paper of the regular program: "A Journal of the Wilkes Exploring Expedition." The journal in question is a manuscript by Mr. Sinclair, the navigating officer of Captain Wilkes' flagship. Dr. Hay sketched the history of the Wilkes' expedition, gave the personnel of the scientific staff, and an account of the itinerary of the voyage. He also noted the character and manner of distribution of the de luxe report on the expedition, which was in 20 volumes and of which only 100 sets were distributed.

The journal of Mr. Sinclair began at Norfolk, Va., August 9, 1838. Dr. Hay read various excerpts, relating to the following subjects: the death and color changes of the dolphin, a waterspout, phosphorescence, behavior of whales; notes on the towns of the west coast of South America, including Valparaiso and Callao; description of the cruise to the Antarctic, including notes on the aurora, icebergs, penguins, seals, storms and the discovery of land; the last excerpt read was a description of San Francisco. The paper was discussed by Drs. M. W. Lyon and Theodore Gill.

The second contribution to the program was an account of the home and country of Linnæus by S. M. Gronberger, illustrated by lantern slides. Mr. Gronberger sketched the home, school and professorial career of Linnæus, and gave an account of his travels. He showed views of Linnæus's home and country, as it now is, and spoke of the distinguished visitors entertained by Linnæus and the mode of life of these companies. Numerous views of places of historical interest also were shown.

The evening's program was completed by the exhibition of an interesting series of lantern slides of Washington's wild flowers by L. D. Halleck. Wm. Palmer spoke briefly on certain of our wild flowers, remarked on their cultivation, and gave running comments on the slides

W. L. McAtee,
Recording Secretary pro tem.

SCIENCE

FRIDAY, JUNE 12, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FINANCIAL STATUS OF COLLEGE TEACHERS[1]

IN 1908 the Foundation reported in its second bulletin the results of an enquiry concerning the financial status of the teaching staff of higher institutions in America and Germany. An examination of salary schedules for the year 1912–13 makes it possible to treat certain of the topics of that bulletin more fully and to measure the change in salaries during the past five years.

THE VARIABILITY OF SALARIES IN THE SAME INSTITUTION

A small institution performing a fairly unified educational service, such as giving instruction in the traditional academic subjects, or training engineers, or teaching law, may do its work conveniently with a staff of men graded rather sharply as, say, professors, assistant professors and instructors, with a fixed salary attached to each grade or title. The teaching staff may even be on almost absolute financial equality, four fifths of its members being "professors" and doing the work of teaching with here and there an assistant of lower title and salary.

Such simple fiscal arrangements were common a generation ago; they still persist in some of the older and smaller colleges; but they are now becoming obsolete, and no one can understand the financial sta-

[1] Based upon a study by Professor Edward L. Thorndike, of Teachers College, Columbia University, of reports made by the institutions to the Foundation. From the eighth Annual Report of the President of the Carnegie Foundation for the Advancement of Teaching.

tistics of our higher institutions by thinking of the teaching staff as sharply graded by a few academic titles, and of each title as significant of a given salary. Where there are professional schools, the salary attached to the title of professor may, in the same institution, range from $500 to a maximum of $5,000, there being actually twenty-five different sums received as annual salaries by the full professors in a single American university. In this institution thirteen different sums, ranging from $750 to $4,000, were received by persons who held the title of associate professor; fourteen different sums, ranging from $1,800 to $3,600, by assistant professors; and eighteen different sums, ranging from $200 to $2,000, by instructors. There were also clinical professors, clinical instructors, and several other academic grades causing further variability, and within each of these grades there was a still further variability of its own.

Even where there are no professional schools, the variation of salary is very great. For example, in two institutions without professional schools nineteen different sums, ranging from $2,000 to $5,000, were received by professors; thirteen different sums, ranging from $600 to $1,700, by instructors; and sixteen different sums, ranging from $1,000 to $3,000, by officers of intermediate grades. This variation is for the salaries of men—were women included, it would be greater. So far as could be ascertained, all of the salaries considered, except perhaps some of those for instructors, were for the full year's work of full-time teaching. There were both lower and higher salaries than those mentioned, but these were for exceptional conditions, as of part-time teaching or administrative work.

Both institutions illustrate the overlapping of academic grades with respect to salary. Over one fourth of the teachers of intermediate grade receive salaries as high as, or higher than, the lowest full professor's salary; nearly one fourth of the instructors receive salaries reaching or passing the lowest point for salaries of teachers of intermediate grade. Such overlapping is in no sense exceptional; in the larger institutions the fact that certain individuals of lower rank receive more salary than other individuals of higher rank is so frequent as to be almost the rule.

THE SALARIES OF THE TEACHING STAFF OF COLLEGES AND UNIVERSITIES IN 1912–13

Such variability of salary for the same academic grade, either by the separation into distinct salary steps or by a gradual ranging, together with the overlapping of academic grades in salary, make the financial statistics of higher institutions difficult to present and interpret without misleading. The difficulty is increased by the differences in practise between institutions and between the same institution in different years, with respect to the significance of a given academic rank. For example, associate professors may be far above assistant professors in dignity and salary in one institution and in another be substantially on a level with them. The average salary of assistant professors may appear to have been lowered between 1907–08 and 1912–13, when in reality such service was better rewarded than before by the addition of a higher intermediate grade or title for those performing this service, and the relegation of the title of assistant professor to those performing a different service. Other complexities are added by differences in policy as to the distribution of salaries within the same grade, differences in the services performed by different individuals of the same grade, and the like.

The only sound and adequate basis for

a statement of the financial status of the teacher in a higher institution is a list of names, giving in each case salary, age, absence and pension rights, services performed, services permitted outside the institution, amount of training, and amount of experience in the institution and elsewhere. No college or university publishes such a list, and it is doubtful whether any governing board keeps such a systematic list, though it is precisely these facts that a competent head of department or college president has in mind and combines with his knowledge of the teacher's scholarship, efficiency and devotion in recommending financial provisions. It is a regrettable fact that at present we know far more about such topics as the relation of age to salary, or of length of experience to salary, in the case of elementary and high school teachers than in the case of college teachers. Indeed, the published facts for the last are practically limited to the survey made in the bulletin of the foundation to which reference has been made.

The first step obviously is to provide knowledge of the salaries that are actually paid, and this the foundation is enabled to do, through the courtesy of institutions in submitting their pay-rolls for study. As the common statements of average salaries give such imperfect and misleading notions, the detailed distribution of the relative frequencies of each salary has been studied.[2]

The facts as reported are not offered as infallible in every respect. The foundation was unwilling to impose on the institutions concerned the burden of answering detailed questions; consequently a salary may occasionally be recorded as smaller than it really was (because the individual was on leave of absence for part of the year, or was in receipt of an added payment under another department), or as larger than it really was (because a payment recorded on the pay-roll in a second department was actually included in the first payment recorded). Some mistakes of copying in and from the pay-rolls and in further tabulations are probably inevitable. The facts reported give, however, a thoroughly trustworthy general picture of what they attempt to present.

The facts compiled are for salaries in 1907–08 as well as in 1912–13, permitting measurements of the rise of salaries as well as of the present status. They are arranged

[2] Some thirty group tables were made for the following colleges and universities: *Group 1*, Carleton College, Franklin College and Ripon College; *Group 2*, Bates College, Clarkson School of Technology, Drury College, Grinnell College, Lawrence College and Mount Holyoke College; *Group 3*, Drake University and Newcomb College (of Tulane University); *Group 4*, Beloit College, Centre College of Kentucky, Dickinson College, Hobart College, Marietta College and Wabash College; *Group 5*, Hamilton College, Oberlin College, University of Pittsburgh, Tufts College and Washington and Jefferson College; *Group 6*, Middlebury College, University of Rochester, University of Vermont and Wellesley College; *Group 7*, Bowdoin College, Clark College, Indiana University, Purdue University, Swarthmore College, Trinity College (Connecticut) and Union College; *Group 8*, Dartmouth College, University of Missouri and Worcester Polytechnic Institute; *Group 9*, Lehigh University, University of Minnesota, Tulane University, Washington University (Missouri) and Western Reserve University; *Group 10*, University of Cincinnati and Vassar College; *Group 11*, Amherst College, University of Virginia and Williams College; *Group 12*, Cornell University, University of Michigan and University of Wisconsin; *Group 13*, Case School of Applied Science, Rensselaer Polytechnic Institute and Stevens Institute of Technology; *Group 14*, University of California, Massachusetts Institute of Technology and University of Toronto; *Group 15*, Johns Hopkins University, Leland Stanford Junior University, Princeton University and Yale University; *Group 16*, Columbia University and Harvard University. None of these group tables is here published, but the foundation will be glad to make them available to scholars.

in four divisions—salaries for instructors or tutors or whatever grade represents approximately the first rank of teachers with a full program, salaries for full professors, salaries for standard intermediate grades, and salaries for all of these grades combined. The salaries of assistants, or whatever grade represents approximately the work of men who are primarily students, are not included. The salaries of irregular grades, such as lecturer, which may carry an instructor's work or a part-time professor's work, or signify casual visits, or a dignified assistantship, are likewise excluded. Presidents are also excluded, but deans and directors of schools or departments are included. Teachers in medical schools, dental schools and schools of pharmacy are also excluded, being more fitly made the subject of separate study. Payments for work in summer schools are excluded. The salary of a teacher in service for only one semester is recorded as it would be for a full year's service. The aim is to show the recompense given for what is a teacher's full service in any institution in question. Although there are doubtless occasional failures to make the necessary distinctions precisely, the tables show the typical with adequate precision. In the salary scales, which form parts of the table, \$400 means from \$350 to \$449, \$500 means from \$450 to \$549, \$600 means from \$550 to \$649, and so on.

Upon examination of Table I. it will be seen that the institutions do not differ very greatly in the salaries given to instructors. We may, without serious error, group all these salaries for all institutions. The low-salaried institutions pay in the main from \$750 to \$1,200, the others from \$750 to \$1,500. It must be remembered that some of the instructors in the larger institutions included in these tables, though carrying a full program of class teaching, are really of the apprentice type, engaged in study for a higher degree. The instructor in these colleges is somewhat better paid than the male teachers in American high schools. The median salary for the latter is \$900; the average salary, little if any over \$1,000; and the proportion of salaries at \$500 to \$900 much greater. It is perhaps worthy of mention that the salaries of the mechanics employed in university shops and laboratories are distinctly below the average instructor's salary in the same institution. Fuller analysis of the financial status of the instructor must be delayed until enough individual life-histories of college teachers are available to permit the correlation of salary with age, experience in teaching, and amount of education received in preparation for teaching.

In the salaries attached to intermediate grades, associate professors, and assistant professors, institutions differ more widely. The gradation is rather steady, so that any grouping of the institutions has to be somewhat arbitrary, and its results are necessarily less instructive. There are groups of institutions with average salaries for the intermediate grades of \$1,200 to \$1,400; with average salaries of \$1,488, \$1,537 and \$1,571; with average salaries of \$1,747 to \$2,076; and lastly the Harvard-Columbia group with average salaries still higher.

These summaries appear in Table II. There are no clear "species" of teachers in this grade from the fiscal point of view. By reason of age, ability and differences in the significance of the titles concerned, the salaries spread from \$1,000 to \$4,000 with no close grouping around specially frequent salaries, save perhaps around \$1,500 for the colleges of moderate salary-schedules. If the grade of associate professor had been kept separate throughout, there would have been a somewhat, but not much, closer

TABLE I

THE SALARIES OF INSTRUCTORS IN 1912–13

Annual Salary	In Group A[3]		In Group B[4]		In Group C[5]		In All Institutions Combined	
	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency
$400	1	.9					1	.1
500	2	1.7	1	.1	1	.3	4	.3
600	3	2.6	5	.6	6	1.5	14	1.0
700	2	1.7	24	2.8	6	1.5	32	2.3
800	14	12.0	68	7.9	22	5.5	104	7.5
900	11	9.4	66	7.6	11	2.8	88	6.4
1,000	40	34.2	219	25.3	90	22.6	349	25.3
1,100	10	8.5	112	13.0	16	4.0	138	10.0
1,200	22	18.8	142	16.4	68	17.1	232	16.8
1,300	2	1.7	81	9.4	41	10.3	124	9.0
1,400	7	6.0	87	10.1	39	9.8	133	9.6
1,500	1	.9	40	4.6	54	13.6	95	6.9
1,600	2	1.7	8	.9	15	3.8	25	1.8
1,700			4	.5	5	1.3	9	.7
1,800			1	.1	10	2.5	11	.8
1,900			2	.2	1	.3	3	.2
2,000			2	.2	12	3.0	14	1.0
2,100								
2,200			1	.1			1	.1
2,300			1	.1			1	.1
2,400								
2,500			1	.1	1	.3	2	.1
Number of individuals........	117		865		398		1,380	
Average salary...	$1,027		$1,121		$1,238		$1,147	
Median salary ...	$1,000		$1,100		$1,200		$1,100	

clustering around central points in the case of either grade. In the case of Columbia and Harvard, where the grade of associate professor is distinctly superior in

[3] Group A includes Carleton, Franklin, Ripon, Bates, Clarkson, Drury, Grinnell, Lawrence, Mount Holyoke, Drake, Newcomb, Beloit, Centre, Dickson, Hobart, Marietta, Wabash, Hamilton, Oberlin, Pittsburgh, Tufts and Washington and Jefferson.

[4] Group B includes Middlebury, Rochester, Vermont, Wellesley, Bowdoin, Clark (Collegiate), Indiana, Purdue, Swarthmore, Trinity (Connecticut), Union, Dartmouth, Missouri, Worcester Polytechnic, Lehigh, Minnesota, Tulane, Washington (Missouri), Western Reserve, Cincinnati, Vassar, Amherst, Virginia, Williams, Cornell, Michigan, Wisconsin, Case, Rensselaer and Stevens.

[5] Group C includes California, Massachusetts Institute of Technology, Toronto, Johns Hopkins, Leland Stanford, Princeton, Yale, Harvard and Columbia.

TABLE II

SALARIES OF COLLEGE TEACHERS OF INTERMEDIATE GRADE IN 1912–13

Associate Professors, Assistant Professors and Preceptors; Junior Professors in the University of Michigan

Annual Salary	In Institution Groups in Which the Average Salary for This Grade is $1,200 to $1,400[6]		In Institution Groups in Which the Average Salary for This Grade is $1,488 to $1,561[7]		In Institution Groups in Which the Average Salary for This Grade is $1,747 to $2,076[8]		In Columbia and Harvard Universities	
	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency	Gross Frequency	Percentile Frequency
$800	1	1.6						
900								
1,000	5	7.9	2	1.5	6	.7		
1,100	6	9.5	2	1.5	2	.2		
1,200	17	27.0	16	8.6	17	1.9		
1,300	9	14.3	10	5.3	12	1.3	1	.6
1,400	11	17.5	22	11.8	13	1.5		
1,500	6	9.5	59	31.5	113	12.7	2	1.3
1,600	5	7.9	29	15.5	89	10.0		
1,700	3	4.8	14	7.5	49	5.5		
1,800			21	11.2	122	13.7		
1,900			1	.5	39	4.4	2	1.3
2,000			8		200	22.5	20	12.5
2,100			1	.5	13	1.5	2	1.3
2,200					37	4.2	17	10.6
2,300					30	3.4	4	2.5
2,400					32	3.6	5	3.1
2,500			1	.5	65	7.3	29	18.1
2,600			1	.5	6	.7	10	6.3
2,700					9	1.0	2	1.3
2,800					8	.9	1	.6
2,900					2	.2	1	.6
3,000					25	2.8	38	23.8
3,100								
3,200							1	.6
3,300							3	1.9
3,400								
3,500						.1	12	7.5
3,600							1	.6
3,700								
3,800							1	.6
3,900								
4,000							7	4.4
4,400							1	.6
Number of individuals........	63		187		890		160	
Average salary...	$1,300		$1,544		$1,924		$2,648	
Median salary....	$1,300		$1,500		$1,900		$2,500	

[6] Including the colleges in groups 1 to 4. See note on page 849.

[7] Including the colleges in groups 5 to 7. See note on page 849.

[8] Including the colleges in groups 8 to 15. See note on page 849.

TABLE III

THE SALARIES OF FULL PROFESSORS IN 1912–13

Frequencies of Each Salary Amount in Specified Groups of Institutions

Annual Salary	In Carleton, Franklin, and Ripon	In Bates, Clarkson, Drury, Grinnell, Lawrence, and Mount Holyoke	In Drake, Newcomb, Beloit, Center of Ky., Dickinson, Hobart, Marietta, and Wabash	In Hamilton, Oberlin, Pittsburgh, Tufts, Washington and Jefferson, Middlebury, Rochester, Vermont, and Wellesley	In Bowdoin, Clark College, Indiana, Purdue, Swarthmore, Trinity (Conn.), and Union	In Dartmouth, Missouri, Worcester Polytechnic, Lehigh, Minnesota, Tulane, Washington (Mo.), and Western Reserve	In Cincinnati, Vassar, Amherst, Virginia, Williams, Cornell, Michigan, Wisconsin, Case, Rensselaer, and Stevens	In California, Massachusetts Technology, and Toronto	In Johns Hopkins, Stanford, Princeton, and Yale	In Columbia and Harvard	Frequencies in All Institutions Combined, Scaled by Steps of $500		
												Gross	Percentile
$800			1										
900											$750		
1,000			1								to 1,249	12	.8
1,100													
1,200	8	1	1										
1,300	1	2		1									
1,400	7	3	2	1							1,250		
1,500	2	12	13	4	5						to 1,749	147	9.3
1,600	2	16	1	5	2	2							
1,700	1	28	35	2									
1,800	3	5	21	14	4	3		1					
1,900			6	4							1,750		
2,000	2	5	2	64	16	10	2	1	3		to 2,249	227	14.3
2,100				9	7	1			1				
2,200			2	24	1	15		1					
2,300			1	4	13	10	3	2	1				
2,400			2	4	13	19	1				2,250		
2,500		1	3	21	42	11	44	6	12	4	to 2,749	266	16.8
2,600				2	1	10	1	1		under			
2,700			3		12	10	7	2	2	3,000			
2,800				4	12	11	6	1					
2,900						19	7				2,750		
3,000			1	6	5	25	77	18	38	3	to 3,249	286	18.1
3,100				1	1	10							
3,200					1	4	33		1				
3,300			1			4	24	7	2				
3,400					2	2			3		3,250		
3,500					1	5	67	8	25	8	to 3,749	205	13.0
3,600				1		18	4	16	2	3			
3,700						2							
3,800							6	1	2	1			
3,900							2		2		3,750		
4,000					1	8	32	37	63	35	to 4,249	194	12.3
4,100						1	2						
4,200									1				
4,300							1	1					
4,400						1			1	2	4,250		
4,500						1	7	3	22	27	to 4,749	67	4.2
4,600										1			
4,700													
4,800													
4,900											4,750		
5,000						5	3	8	34	44	to 5,249	95	6.0
5,100													
5,200										1			
5,300										1			
5,400										1	5,250		
5,500									3	34	to 5,749	40	2.5
5,600													
5,700										1	5,750		
5,800											to 6,249		
5,900													
6,000							3		1	21		25	1.6
Over 6,000									1	17	Over 6,250	18	1.1
											1,582 individuals Median salary $3,000		

salary, there would be a fairly pronounced influence of this sort.

We may say roughly that the teachers in intermediate grades in the smaller institutions are financially in a class with the instructors in institutions like Columbia, Harvard, Yale, Hopkins, Stanford, California and Princeton. How often they are, like these latter, young men proving their worth, and how often they are mature men whose achievements have not been such as to put them ahead financially, is a question to be settled only by proper measurements of the correlation of age with salary. The teachers in intermediate grades of institutions like Oberlin College get from $1,200 to $1,800, and represent gifted young men, somewhat older men waiting for fairly assured promotion, and still older men who have nearly or quite reached their salary limit as college teachers. The 890 teachers in intermediate grades in institutions like Dartmouth College or the University of Minnesota represent the group of assistant professors whose status has been studied by Professor Guido Marx, plus a financially superior group of junior professors and associate professors in large institutions.

In the case of the full professors, we have in Table III. the story of the salaries of mature men and women, accepted as teachers of the highest rank, in sixty-one institutions. This fairly represents the status of the full professor in the hundred and fifty better higher institutions of America.

There is a certain significance in the combined facts for the salaries of all these full-time teachers of accepted standing in the higher schools of America, which are shown in Table IV., although in this table all ages and all of the institutions are mixed. The significance lies in the possibility of easy comparison with similar facts for other professions or branches of civil service, and of easy contrast with salaries in industrial and commercial organizations. One such comparison with the salaries of men teachers in public high schools of the United States is made in the table itself.

TABLE IV

THE DISTRIBUTION OF THE SALARIES 1912–13

Of the 4,262 Instructors, Assistant Professors, Associate Professors and Professors in the 61 Institutions Combined

Salary	Frequency			Totals	Totals Expressed in Percentages	Similar Percentages for Male Teachers in Public High Schools in 1908 (approximate)
	Instructors	Teachers of Intermediate Grades.	Full Professors			
Under $750	51			51	*1.2*	*30.5*
$750 to 1,249	911	74	12	997	*23.4*	*44.3*
1,250 to 1,749	386	447	147	980	*23.0*	*13.0*
1,750 to 2,249	29	483	227	739	*17.3*	*7.1*
2,250 to 2,749	3	194	266	463	*10.9*	*3.1*
2,750 to 3,249		76	286	362	*8.5*	*1.6*
3,250 to 3,749		17	205	222	*5.2*	*.5*
3,750 to 4,249		9	194	203	*4.8*	
4,250 to 4,749			67	67	*1.6*	
4,750 to 5,249			95	95	*2.2*	
5,250 to 5,749			40	40	*.9*	
5,750 to 6,249			25	25	*.6*	
Over 6,250			18	18	*.4*	
Number of individuals........	1,380	1,300	1,582	4,262		

THE RELATION OF SALARY TO AGE

An adequate treatment of the relation of salary to age requires the fiscal history of individual teachers. To infer the changes in salary due to age from the differences found between the salaries of groups classified by age is unsafe, since those who abandoned college training for other occupations at any age are very likely to differ as to salary from those who remain, and since we can not assume that the ability of those entering college teaching has remained constant during the forty years past. The foundation hopes to give the topic such adequate treatment in the future. The present section reports only measures of the variation of salary at the same age for certain groups—a limited and not exactly representative selection from college teachers of 251 men, all teachers of mathematics or the natural sciences in certain universities, who had been active enough in science by the year 1910 to be included in the second edition of Professor Cattell's "American Men of Science." The choice of these was dictated by practical exigencies and the results must not be taken strictly at their face value, although the use made of the facts has been kept free from fallacies due to the nature of the selection of these individuals. The selection is such as to exclude men of all ages of slight scientific achievement and to exclude somewhat more strictly the youngest. Also, as stated, it is a selection of men from, on the whole, a superior group of institutions.

In general, we have a fairly steady rise in salaries from the group of age 34 with a median salary of $1,800, through age 36 at $2,000, age 38 at $2,200, age 40 at $2,500, age 42 at $2,200, age 45 at $2,850, to $3,200 at age 49, and $3,300 at age 53. For the reasons stated, this result should be used with caution. What is certain is that the effect of age within these limits is real, large and more persistent to later ages than probably would have been assumed *a priori*.

There is an interesting difference in salary and in the relation of age to salary between the men who were rated in Professor Cattell's list of the 1,000 most esteemed as scientific workers and those who were less distinguished. In salary the more distinguished group have an advantage of about $800 at ages 36 and 38, about $1,000 at ages 40 and 42, about $1,500 at ages 44 and 46, and a still greater advantage at later ages. The median salary for the distinguished group rises from about $3,000 at ages 36, 38, 40 and 42, to $3,500 at ages 44 to 46, $4,000 at ages 48, 50, 52 and 54, and $5,000 at higher ages; while the median salary for the others remains at approximately $2,000 through ages 36 to 46, and is only $2,500 and $2,650 in the case of ages 48 to 54 and 56 and over. These figures are from too few cases to be used as precise measures of the differences in question, but are adequate to prove that ability as estimated by one's fellow scientists receives very substantial recognition in salary, and that, as in other professions and in industry and commerce, the less gifted men reach their maximum salary much earlier than the more gifted.

The variation in salaries for the same age is, as students who have made the matter a subject of careful observation and thought would expect, very wide. Men not over two years apart in age differ in respect to salary to such an extent that the highest salary is about four times the lowest. The intervening salaries are spread fully over the scale. Men receiving $2,000 may be from under 30 to over 60 years old, and men can be found with that salary at every intervening age. The effect of more

complete and more exactly representative data would be to increase the range of variation. This variation, it may be added, is a sign of healthy adaptation to the wide differences in energy, scholarship and devotion which must be expected even within such a picked group of men as college teachers.

THE APPRENTICESHIP SYSTEM IN AMERICAN HIGHER INSTITUTIONS

The higher institutions of America maintain an elaborate system of apprenticeship by their provision, fiscal and otherwise, for assistants, readers, teaching fellows and the like, who do educational work under more or less close supervision, generally as part-time workers who are studying for a degree, or who have just completed such study and are maintaining financial independence while waiting for engagement as full-time teachers.

The extent of this apprentice work in the larger institutions may be estimated from the fact that in Columbia, Harvard, Chicago, Michigan, Yale and Cornell there are reported 761 individuals with the title of assistant, more than the number of full-time professors in these same institutions. Some few of these are full-time teachers or scientific workers of experience,[9] but there are, to much more than counterbalance these, teaching fellows and young men with the title of instructor who are really apprentices.

The system is by no means confined to the large universities. Taking at random ten institutions of moderate size (Vassar, Indiana, Purdue, Oberlin, Cincinnati, Armour Institute, Virginia, Washington, Western Reserve and Brown), we find reported 237 assistants to 321 full professors. Moreover, there probably are other student assistants unreported because receiving only free tuition.

Even in the small institutions, much of the educational work is done by, and much practical training in college teaching is given to, such apprentices. Again taking ten colleges at random (Lafayette, Bowdoin, Colorado College, Dickinson, Adelphi, University of South Carolina, Goucher, Trinity (Connecticut), Beloit and Washington and Jefferson), we find reported 72 assistants to 157 full professors. Fifty-two of these were reported from a single institution, but, on the other hand, the student-assistants who were given tuition or tuition plus a hundred dollars or so were probably very often left unreported by other institutions in this group.

The fiscal status of these apprentices will not be described here, since any tables of salaries or changes in salaries for them are likely to be misleading unless worked out and presented in connection with fairly exact descriptions of the services which they perform and the training which they receive. These services range from the actual conduct of class-room and laboratory instruction to the mere correction of minor written exercises, or even to work as errand boys, keeping class-rolls, answering the telephone and fetching apparatus. In time required they vary so much that an assistant's pay probably would show a range of from fifty cents per hour to five times as much. The training ranges from such sympathetic guidance as a son might receive in a model father's office to the mere orders and criticisms that an ordinary office boy gets.

It is probable that four out of five of the men and women now entering college and university teaching hold such positions as paid assistants for a year or more. Consequently the organization and remuneration

[9] In departments of agriculture especially, subordinate scientific workers with salaries of from \$800 to \$1,500 are often given the title of "assistant."

of the work attached to assistantships offers important problems to the scientific student of administration. At its best an assistantship means self-support while advancing in knowledge and professional training for the assistant, equally good instruction for the classes in question, relief for the professor who can devote himself to work that he prefers, though it is in the popular sense much harder to do, and economy for the fiscal authorities who are enabled to pay certain services no more than efficiency requires.

THE CHANGE IN THE SALARIES OF TEACHERS IN HIGHER INSTITUTIONS

The salaries of instructors have shown a clear increase during the past five years. There has been an average gain of $80. This gain has been caused by a decrease in the proportions of salaries of $1,000 and under and an increase in the proportions of salaries of $1,050 and over. The increase has been greatest in the groups of institutions paying on the average under $1,000 in 1907–08. The gain for these averages $118, and their median salary has moved up from $900 to $1,000. The gain has been least in the institution groups which had the highest salaries in 1907–08, except Harvard and Columbia, being $63 for the combined group including California, Massachusetts Institute of Technology, Toronto, Johns Hopkins, Stanford, Princeton, Yale, Harvard and Columbia, and much less if Harvard and Columbia are excluded.

Table V. gives the percentage of instructors receiving less than $650, the percentage receiving from $650 to $849, the percentage receiving from $850 to $1,049, and so on, both for 1907–08 and for 1912–13. It will be seen that all the low salaries have decreased in relative frequency, while all the high salaries have increased.

TABLE V

CHANGE IN INSTRUCTORS' SALARIES

All Institutions Combined; Coarse Grouping

Salary	Percentile Frequencies		Differences
	1907–08	1912–13	
Under $650	2.6	1.4	− 1.2
$650– 849	13.0	9.9	− 3.1
850–1,049	42.6	31.7	−10.9
1,050–1,249	23.6	26.8	+ 3.2
1,250–1,449	10.8	18.6	+ 7.8
1,450–1,649	6.2	8.7	+ 2.5
1,650–1,849	.7	1.4	+ .7
1,850–2,049	.5	1.2	+ .7
2,050–2,249		.1	+ .1
2,250–2,449		.1	+ .1
2,450–2,649	.1	.1	0

The change in the salaries paid to teachers of intermediate grades is complex and difficult to express. In the institutions paying in 1907–08 in most cases from $1,000 to $1,500, clustered around an average of about $1,200, there has been an average gain of about $200. This gain concerns positions filled by 110 individuals in 1907–08, and by 161 in 1912–13. In Harvard and Columbia, at the other salary extreme, there has been an average gain of $226. Here 116 and 160 positions were concerned in 1907–08 and 1912–13, respectively. The remaining institutions, with 660 positions for 1907–08 and 979 for 1912–13, show an average gain of about $120, the gain being closely the same whether an average of $1,500, $1,600, $1,700, $1,800 or $2,000 was paid in 1907–08. The intermediate grades have then made most improvement in the institutions which in 1907–08 paid the very low or the very high salaries.

The general change is shown in Table VI. which gives the percentages (in 1907–08 and in 1912–13) of teachers receiving each salary amount. The grouping shows with special clearness the decrease in relative frequency of salaries below $1,500 and the increased relative frequency of salaries above $1,850. The change has been

an advance all along the line, not the mere bringing of very low salaries up to a higher standard, nor the addition of certain high-priced positions.

TABLE VI

THE CHANGE IN SALARIES OF TEACHERS OF INTERMEDIATE GRADES FROM 1907–08 TO 1912–13

All Institutions Combined; Coarser Grouping

Salary	Percentile Frequencies 1907–08	1912–13	Differences
Under $950	.4	.1	− .3
$950–1,249	11.6	4.8	−6.8
1,250–1,549	23.7	19.8	−3.9
1,550–1,849	25.9	25.7	− .2
1,850–2,149	20.1	22.0	+1.9
2,150–2,449	6.1	9.6	+3.5
2,450–2,749	8.2	9.5	+1.3
2,750–3,049	2.6	5.8	+3.2
3,050–3,349	.4	.3	− .1
3,350–3,649	.2	1.1	− .9
3,650–3,949	.1	.1	0
3,950–4,249	.4	.6	+ .2
Number of individuals....	946	1,300	

The salaries of full professors in these institutions have been increased on the average by about $225, the increase being about the same for institution groups paying salaries, in 1907–08, of $1,200, $1,400, $1,600, $1,800, $2,200, $2,700 or $3,000. The institution groups paying average salaries (in 1907–08) of $3,500 and $3,750 show smaller gains, about $125; Columbia and Harvard show larger, about $350. The low-salaried institutions have thus increased their professors' salaries by a percentage far greater than that of the high-salaried institutions. The general change is shown in Table VII. which gives the relative frequencies of each salary amount in steps of $500 in 1907–08 and 1912–13 for all of the institutions combined. The decrease in the lower salaries is clearly shown, the professorial staff having been moved up by about $200 all along the salary scale.

TABLE VII

THE CHANGE IN SALARIES OF FULL PROFESSORS FROM 1907–08 TO 1912–13

All Institutions Combined; Coarse Grouping

Salary	Percentile Frequencies 1907–08	1912–13	Differences
$750–1,249	2.9	.8	−2.1
1,250–1,749	12.3	9.4	−2.9
1,750–2,249	16.2	14.5	−1.7
2,250–2,749	15.3	17.1	+1.8
2,750–3,249	19.9	17.6	−2.3
3,250–3,749	9.9	12.6	+2.7
3,750–4,249	12.6	12.3	− .3
4,250–4,749	2.8	4.3	+1.5
4,750–5,249	4.4	6.1	+1.7
5,250–5,749	2.1	2.6	+ .5
5,750–6,249	.5	1.6	+1.1
Over 6,250	1.0	1.2	+ .2

From the results of this new examination of the financial status of college teachers, it will be seen that the situation, as compared with that of five years ago, is encouraging. In spite of a variability of salaries in the same institutions and of a financial overlapping of academic grades, there is coming to be a kind of general agreement upon a salary for a college instructor that is rather better than that of the man who teaches in a high school. Junior professors in the smaller colleges receive salaries almost equal to those of instructors in the large universities. Of 1,500 representative full professors one fourth receive $2,250 or less, one fourth $3,750 or more, and one tenth $5,000 or more, the median salary of all being $3,000. All salaries have increased during the last five years—those of instructors have risen by about $80, those of junior professors show a gain of from $120 to $226, those of full professors show an increase of from $125 in the smaller institutions to $350 in the largest. Teachers who by general agreement are considered distinguished receive from $800 to $2,400 more than their colleagues of the same age.

SOIL EROSION AND ITS REMEDY BY TERRACING AND TREE PLANTING[1]

PEOPLES have the habit of visiting their heaviest penalty—death—upon those offenders who imperil the life of the community. For example, horse-stealing among cowboys, destroying bridges among the Caucasus mountaineers. By the same reasoning the time is approaching when the permitting of gullying and soil erosion will rise in our minds from waste to offense and finally to crime.

Soil erosion is an irreparable waste, perhaps the only irreparable waste, when in an age of science one considers the great possibility of substituting one substance or commodity for another. Once the soil is gone, it is gone, and can not be returned. In locations of shallow soils underlaid with rock, a very small amount of erosion throws land out of agricultural use for a geologic epoch.

Owing to our vast resources and cheap land and the scientific nature of erosion control, little has thus far been done to check erosion either prohibitively or constructively. Another reason why we have done or appreciated so little in this field is that the problem is relatively new to the Teutonic peoples.

I. FACTORS TENDING TO AGGRAVATE AND INCREASE SOIL EROSION IN AMERICAN AGRICULTURE

1. *Relation of Agricultural to Nature's Erosion Control.*—Nature controls erosion with plant roots, so that in most of the United States the problem scarcely existed before white men's agriculture began here. The beginning of agriculture here was not merely the introduction of an old-established method. American agriculture is unlike that of Europe and far more deadly as a promoter of erosion. European agriculture has but little bare ground, most of the crops covering the entire surface of the ground and holding it with a root mass, as does wheat, barley, clover. America has added to the European agriculture the three great bare-ground crops of corn, cotton and tobacco. The tillage of these crops prepares the ground for erosion. The soil is kept bare, loose and soft. Frequent cultivations gash it ready for the starting of the digging rills of running water when a storm comes.

2. *The New and Erosive Type of Rainfall.*—Another factor, new to the Caucasian race, is a heavy summer rain which exists in all the territories growing these three crops, and comes in the peculiarly destructive form of a thunder shower, with its tremendous powers of eroding loose bare soil.

3. *The Increasing Area of Erosion-inducing Crops.*—The increasing demand for these bare-ground crops tends more and more to make us cultivate and destroy hilly lands which, while in good pasture or forests, erode but little.

II. FACTORS IN EROSION CONTROL

1. Deep plowing has been extensively recommended by our agricultural authorities, but casual observance of hill lands almost anywhere shows it to be but a partial remedy, and corn and cotton fields under the best recommended deep plowing can often be shown to be eroding at rates that are completely ruinous if kept up for any long period.

2. Contour plowing tends to diminish erosion, but this device is hostile to the American system of farming that is characterized by the utilization of machinery sweeping in straight lines over large areas.

3. Terracing has been quite widely used in the south, but usually in a relatively inefficient way because in effect it chops a field up into a multitude of small fields of irregular shape. Between these little patches are untilled banks that grow weeds instead of crops. We have, however, the recent discovery of the Mangum terrace worked out by a farmer at Wake

[1] Section I., of the A. H. A. S., has a committee on soil erosion. This committee appointed J. Russell Smith, Ph.D., professor of industry in the Wharton School of Finance and Commerce, University of Pennsylvania, a subcommittee to gather information as to the relation of tree crops to the erosion problem. This paper presented at the 1913 meeting of the section is the result of journeys of investigation in the Mediterranean countries and islands and in central and southern United States.

Forest, N. C., and now adopted by the Federal Department of Agriculture. It is a great improvement over any terracing to be found in either Europe or America. It consists of wide gentle ridges plowed up along the face of the slope so that the water flows slowly and harmlessly along it, while its wide gentle slope permits the planting of crops and the utilization of agricultural machinery directly across it at the same time that it controls the runaway waters. There is almost no washing of earth where the system is maintained, and the ground is fully utilized in the American way.

A proper appreciation of the economic and far-reaching importance of soil saving should bring us in a short time to a point where, by compulsion or premium, all tilled lands liable to washing would be handled by this method or some other equally efficient one.

4. Plowless utilization of land offers great possibilities for the checking of erosion and the vast increase of our crop area.

(*a*) *Forestry and Pasture*.—Thus far tree planting in the form of forestry has been almost the sole panacea, other than pasture, for steep lands. The fruitlessness and slowness of a forest, which yields its one crop in from twenty to one hundred and fifty years, is a profound objection to it as a resource for the owner of the average small farm. The yield of hill pastures is too small to be a satisfactory dependence. Therefore, we have plowed, gullied and destroyed.

The inefficiency of pasture is indicated by its almost entire elimination in the arable areas of western Europe where it has given away to tilled crops. Its inefficiency in comparison to tree crops is shown by the fact that the pounds of food, the income and the nutrition produced by an acre of good sheep pasture in England are less than that produced by a good walnut tree in France.

(*b*) *Crop Trees*.—The tree is nature's real engine of production. This scientific fact seems to have been overlooked, despite the great value that trees have been to us. By a spasmodic and chance development, the tree has given us a number of valuable tree crops. The land that is in harvest-yielding trees is usually the heaviest yielding and most valuable land. Witness the orchards everywhere. The king of all crops, as measured by the greatest amount of food produced and the value of the land, is a tree crop—the date.

Past development of tree crops has come peculiarly by chance. Now that we know how to breed plants, we need the systematic examination of all the trees of the country with regard to their present or potential crop possibilities. This is a task requiring much work and having tremendous promise of increased national wealth. This conclusion is borne out by the facts now known concerning American trees, and by the occasional development of tree agriculture both in this country and in Europe.

In this country while we have an extensive fruit industry, it has touched but a small corner of the possible tree-crop field, and the crops have been limited chiefly to those fruits that may be classed as succulents rather than nutrients, and they have been limited also to human food rather than to forage. Forage is the great demand upon the American farm. The animals eat several times as much as we do.

1. *Tree Forage*.—Forage tree crops in Europe, Africa and Hawaii, are suggestive of great developments in America. The carob bean, worth about one cent per pound at the farm, is a much prized nitrogenous and also carbohydrate stock food widely grown from Gibraltar to Palestine, and exported to England and to some extent to the United States. In Hawaii we have its counterpart, the mesquite bean, a bran and cornmeal substitute, rapidly becoming an important industry. The yields reported by the Hawaiian Experiment Station are almost staggering in their significance. Mesquite forests on rough untilled and untillable land are producing from 4 to 10 tons of beans per acre and the bean meal sells at $25 a ton. We have in the United States, waiting to be developed, similar leguminous, cropping trees growing from the Pacific to the Atlantic in the form of the mesquite in the west and the honey locust in the east, both great bean-yielding trees.

The European utilization of the acorn as swine food amounts to millions of dollars annually, and while we have some hundreds of thousands of hogs using the bought privilege of eating the acorns of our national forests, no one seems to have seriously considered the possibility of investigating the American oak as a corn substitute, yet there is good reason to believe it may be more effective than corn in many localities. American trees yielding several hundred pounds of acorns are common.

The utilization of the fig in Majorca and Portugal gives us added reason to contemplate the great possible service of mulberries and persimmons as automatic pig feeders, the crop being harvested by the animals themselves. The extensive use of the chestnut as a corn forage substitute in the mountainous parts of Italy, Corsica and France shows us what we might do in Appalachia with native or imported chestnuts, and also with hickories and other native nut trees.

2. *Major Foods from Tree Crops.*—The great dietary wants of man are proteid for tissue, carbohydrate and fat for energy. None of these wants has been met to any important extent by a tree crop in the United States. The proteid demand is substantially met in Europe by the use of the walnut, almond and filbert. Unquestionably the native and Persian walnuts of the United States, along with that remarkable tree, the pecan, and the numerous native hickories and hazelnuts, offer us great possibilities of new and extended industries and new staple food supplies.

The carbohydrate tree crops of the Old World are even more important than the proteids. The date (more nutritious than bread) is the main stay of vast areas, and the fig (even more nutritious than the date) is also a great food. The chestnut is, to large areas of Spain, France, the Mediterranean islands, and Italy, the same thing that corn is to the Appalachian mountaineers—a great starch food. The acorn, with an analysis much like that of wheat, excepting a shortage of protein, has for ages been a food for many Mediterranean peoples, and holds out at any time the possibility of being made into a very acceptable farinaceous food for the American people if they should choose to develop it, in an age of science and factory-prepared foods. Fat is furnished in Europe by the olive to so great an extent that the olive covers a larger proportion of Spain than wheat does in the United States. We have not yet developed an oil industry, although the resources are at hand.

3. *Areas and Adjustment.*—The tree is plainly our best means of utilizing steep and rough land, and if we can develop means of utilizing the cropping tree without the plow, we can easily double the crop area of the United States. At the present time tree crops cover only about one fiftieth of our agricultural area, when they apparently possess the possibility of covering half of it with great profit and with a permanence of production now unknown.

The example of a thousand per cent. increase in value of a Corsican hillside when well established in chestnut orchards that have never been plowed and which have produced for centuries, is exceedingly suggestive.

The problem is not merely a problem in forestry, for it is an established fact, that the fruiting trees must have sunshine on all sides. Numerous modifications of the forestry situation, however, suggest themselves. Tall trees like the pecan might be surrounded by coppices of leguminous trees like the locust, which might attain salable size, and by their nitrogenous roots greatly enrich the soil, as is the case where certain leguminous trees are grown with coffee. Crop trees like the pecan and walnut, persimmon or mulberry might be surrounded by thickets of bush size legumes, which absolutely maintain the soil against erosion, which enrich it, and which might be annually cut in the place of being annually plowed, or they might be pastured once a year with goats, and thus kept under control, made to render their service to the crop tree, and still give some value as forage.

4. *Moisture and Fertility Control.*—American agriculture is unquestionably suffering from too great a conviction that cultivation

is essential to the preservation of moisture and the supplying of fertility.

There is little doubt that the earth mulch, a preparation for erosion, does make the fertility more available, and does check evaporation. We need much more knowledge than we now have as to whether or not the same results may not be obtained by the application of mineral or other chemical fertilizers, which will increase natural vegetation, which will therefore increase humus, and the natural water-holding power of the soil. Rather convincing evidence as to the efficacy of this latter method is to be had in the sod mulch orchards under the care of the Ohio Agricultural Experiment Station, and also in the variation of crop yields in rich and poor lands in a dry season in the Berber villages of Northern Algeria. At the present moment the idea of the maintenance of fertility and a good crop yield without tillage is so unorthodox that almost no experiment stations in the United States will look at the subject with respect, yet in it lies great possibility of the extension of tree-crop agriculture to large areas of land where cultivation is difficult and is almost synonymous with erosion unless careful terracing shall be worked out.

The actual holding of water upon the ground until it sinks in is an aspect of the matter well worthy of extensive investigation. The mangum terrace, which is so efficient in taking water away from a hillside without erosion, can doubtless be enlarged and made absolutely horizontal so that it will keep the water where it falls, after the practise of Colonel Freeman Thorpe, of Hubert, Minnesota. This is a practise worthy of much experimentation, and one which fits peculiarly into the tree-crop idea. It is doubtless true that in many localities the water standing behind the horizontal mangum terrace would injure wheat, clover and other small crops. On the other hand, there seems to be little reason to anticipate that it would injure trees that stood upon the terrace and had their roots beneath the reservoir of water, which might stand and freeze for considerable periods with no injury to the tree, which would get the water when it soaked into the ground. This has been proved successful for 20 years in a Pennsylvania apple orchard.

This practise has been worked out for many decades in the olive orchards of Central Tunis around Sousse, and it unquestionably can be utilized with tree crops in many parts of the United States. Its limitations must be defined by experimentation, which may also find aids in the growth of deep-rooting annual plants to increase porosity and absorbing power of the soil.

There also appears to be no reason why this mangum terrace might not be modified into a series of basins that would hold near each tree the water that fell near it, and thus practically apply the methods of the California water economizing irrigators. Such preparation of the soil would be effective for many years and would therefore be less expensive than annual cultivation.

An effect of this holding of water where it fell would be the absolute stoppage of a loss of fertility that results from the washing away of incrustations of soluble salts deposited through the evaporation of earth moisture at the surface. The effectiveness of this process in bringing earth salts to the surface is well known. It has given us our alkali soils, but we owe it to Colonel Freeman Thorpe to call our attention to its surprising effectiveness as an agency in fertility loss where water is allowed to run off of the surface. This factor alone may be found worthy of all the effort necessary to hold water where it falls.

III. CONCLUSION

If the economic botanists and plant breeders can give us a series of new cropping trees which will furnish new foods for both man and beast, we will have an economic factor which will combine a number of forces, because it helps to meet a number of needs. It will greatly stimulate food production, also wood production. Through the development of the plowless agriculture and terrace water holding, we will have conservation of the soil and of fertility. We will also have in this combination the greatest of all forces yet

brought to bear upon the problem of flood control, and also a great aid to navigation and irrigation, because of the better conservation of water in the soil for springs and streams.

It is a problem with which the individual farmer of an intellectual turn of mind can experiment in a small way, but above all it is one which needs, even demands, the attention of the federal government and many of the agricultural experiment stations.

J. Russell Smith

University of Pennsylvania

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND THE STATE

In an address at the annual banquet of Technology alumni in January, Governor Walsh suggested a closer cooperation between the institute and the state. The result has been, in its successive steps, the appointment of a special committee to consider the matter by Jasper Whiting, president of the alumni association, a conference with the governor in March, an investigation of all the sources of information and a report to the alumni council on May 25. The latter while it has naturally been based on the institute and its resources proves to be so broad in its applications that there is place in the plan for all the institutions of the state that can give advice. "When they are so harnessed to the state's interest," the report reads, "they will constitute a great state university geographically diversified, possessing the momentum of valuable traditions, the strength of long years of experience and moral influence through their great alumni bodies—all this making of them units, which if assimilated by a wise state policy will form a coordinated system of educational facilities, which in its broadest sense is a university."

First there is recommended legislation which shall increase and regularize the services of members of the faculty of the institute (and other institutions, to be specified in the act) on state boards and commissions, either as members or in an advisory capacity. Such legislation should be applicable to all state commissions which conduct work requiring scientific or technical skill or advice. Suggestions for direct payment for such services direct to the institution are made, since it is best fitted to apportion such payments between individual service and the use of the laboratories of the school.

The second recommendation is that the use of the laboratories and shops of the institute be placed at the service of the state under appropriate conditions which will safeguard the educational purpose of the institute and the administrative needs of the state. No direct charge should be made for the use of these laboratories, but the state should bear the expenses of labor and material plus a fixed sum to be added to cover wear and depreciation. Provision should be made for an equitable adjustment of this charge.

For its third suggestion the committee advises the establishment of a bureau of technical information, which shall without charge furnish to the state and the public, advice which may be obtained without substantial expense, either in furnishing ordinary scientific information or indicating the lines of inquiry to be followed.

The committee recommends the appointment by the governor of a permanent committee on cooperation to carry into effect these recommendations, to study further the needs of the state as to closer cooperation between it and the institute and additional means of making such cooperation effective. Such a committee would also look forward to a system of cooperation between the state and the various other educational institutions.

The committee finds that from its inception the Massachusetts Institute of Technology was intended to serve the scientific needs of the state and its people. Its charter looks to aiding the advancement, development and practical application of science in connection with the arts, agriculture, manufacture and commerce. In this department of its activities the committeė finds momental achievements to the credit of Tech in many different divisions of work. In fact the whole history of the institute shows that the institute has given to the state and that the state has drawn freely from

the institute. The state has availed itself of the faculty of technology and of the shops, laboratories and experiment stations and it has furnished problems for the student body. But all of this, the committee believes, has been in an incidental and casual way. There has been cooperation undefined, unguided and fragmentary. It has lacked the stimulus of continuity or organization, the spur of recognized state service. "The time has come," writes the committee, "to formulate the union, to make it official, to the end that the institute may be strengthened, in power and prestige, and that the state may derive in full the benefit at hand."

PRESERVATION OF THE NATIONAL MONUMENTS OF CHINA

PRESIDENT HENRY FAIRFIELD OSBORN of the American Museum of Natural History has addressed under date of May 14, 1914, to Secretary of State Bryan and to President Yuan Shih-k'ai of China, the following letters relative to the preservation of the art and historical monuments of China.

HONORABLE WILLIAM J. BRYAN,
Secretary of State,
Washington, D. C.

Sir: The Chinese race furnishes perhaps the greatest of all records of human society, and its future is closely associated with the destiny of society in this hemisphere. Our country contains an ever-increasing number of men and women devoted to the hope of China's triumph in modern civilization and government, in which case she will extend her matchless social and human experiment continuous from the remotest times unbroken. In this connection interested persons and institutions in the United States are seeking to establish in China a school of archeology as a means to encourage protection of the antiquities of China and provide for study there of China's ancient history.

On account of the ruthless destruction and plunder of antiquities in China since 1900, involving American citizens, the following individuals and organizations represented, having memorialized President Yuan Shih-k'ai as shown herewith, have the honor to request your aid in the official transmission of their memorial herewith enclosed, directly to Peking.

Furthermore, we have the honor to request:

First, That the Department of State, through its officials in China, use such means as it may determine to discourage all American citizens from vandalizing in China and from trafficking in broken and stolen sculptures and other archeological and art works of historical value belonging to the people of China, and to render aid with counsel wherever possible to shield Americans from being involved with plunderers of Chinese antiquities, and in all ways possible assist in preserving the good name of the United States, its citizens, agents and institutions, free from connection with the destruction of Chinese monuments and antiquities and the traffic in stolen and otherwise immorally or criminally obtained Chinese objects of antiquity.

Second, That the Department of State, officially, semi-officially or unofficially, as possible, through its officials in China and elsewhere, discourage the plunder and destruction of Chinese antiquities in times of peace or war in China, whenever opportunities permit, and support and encourage the Chinese officials and people in taking effective means to conserve their antiquities for China's benefit and the benefit of other nations.

Respectfully submitted,
(Signed) HENRY FAIRFIELD OSBORN,
President

PRESIDENT YUAN SHIH-K'AI.

Sir: We have learned with profound concern, that through various evils of modern origin, monuments and antiquities in China invaluable to present and future generations of Chinese and to the world, have been irreparably lost and destroyed; that the high material value put by Western civilization upon antiquities and products of art showing the progress of mankind, has lately resulted in the commercialization, plunder and destruction of antiquities in China beyond the power of ordinary influences to control; furthermore, that such plunder and destruction not only are despoiling China of some of the garments of her ancient civilization, but actually tend to break down Chinese society by depriving the Chinese people of their heritage, besides crippling research and education, and retarding progress;

Therefore, having a friendly interest in the good of China and the republic, and having in mind the interests of enlightenment of human welfare generally, as well as the responsibilities devolving upon the nations and upon all well-wishers and friends of China, we have the honor herein to memorialize your Excellency and respectfully and earnestly to urge as follows:

That in view of all the circumstances and conditions; in accordance with ample traditional practise and precedent established by China's ancient rulers; and in cooperation and harmony with the policy of the most advanced governments, the national government of China make new legal recognition of China's monuments and antiquities, and of all forms of national art of antiquarian and historical value as national property, and, in the manner adopted by other nations, newly take national possession of the same and bring them under national protection for preservation in China for the lasting benefit of the Chinese people and of mankind generally.

Respectfully submitted,

(Signed) HENRY FAIRFIELD OSBORN,
President

THE BRITISH ASSOCIATION IN AUSTRALIA[1]

At the end of June and in the first week of July 400 members of the British Association for the Advancement of Science will leave England to meet for the annual sessions of the Association in the state capitals of Australia. The visit is made at the invitation of the Australian Commonwealth Government, whose guests the members of the association will be, and by whose generosity so protracted a journey is made possible.

Such a meeting is memorable in many ways. It adds completeness to that system of exchange of scientific thought and scientific men between the United Kingdom and the Dominions over-seas which has been steadily growing since the beginning of the century; and it will serve to link still more closely the newer universities with the older throughout the whole of the Empire. The previous visits of the British Association to Canada and to South Africa gave fresh impetus to scientific work, and were followed by tangible results in the creation of new scientific institutions and laboratories. There is assurance beforehand that this precedent will be repeated in Australia, for one of the objects of the visit is to afford opportunities for joint discussion on cooperation in research between the southern continent and the countries of the Northern Hemisphere in astronomical, meteorological and anthropological problems.

There are advantages of a reciprocal kind to those who would not otherwise sacrifice four months of the scientist's year in a visit to Australia. Problems await attack in solar physics and in the distribution of the stars; problems in the evolution of segregated species of animals and plants; of physiological adaptation; of atmospheric electricity and earth magnetism; of the antiquity of races and of the development of social conditions—in short, problems affecting every department of science, which can only be carried to completion with the aid of data obtained in the Southern Hemisphere and the southernmost continent.

The commonwealth government, the state universities and the Australian people are making every provision that the fullest opportunity shall be given to the meeting to investigate both the work that is being done and that which has to be done in the fields of zoology, botany, physiology and engineering. It should be added as not the least remarkable of the circumstances of this meeting that this is the first time that any government has set aside so large a subsidy for the purposes of the encouragement of science.

The members of the association proceed in two parties. The advance party of 70, in which the president-elect, Professor William Bateson, F.R.S., travels, and which takes with it a number of zoologists, botanists and geologists, will go by way of the Cape to Perth, in Western Australia. This party stays a week, making excursions for field work in the sand plains, in the Darling Range, the Irwin River district, the coast or the Kalgoorlie goldfield during the larger part of it; and, at most, three evening lectures will be delivered, one of them by Professor Herdman on "Life of the Sea," and another by Professor A. S. Eddington on "The Stars and their Movements." This visit is an unofficial part of the meeting; but since among those who take part in it are Professor F. W. Dyson (the astronomer royal), Professor H. E. Armstrong, Professor Poulton, Professor Dendy and Professor W. J. Pope (presidents respectively of the

[1] From the London *Times*.

zoological and chemical sections), Professor A. D. Waller, Sir John Biles, Dr. A. C. Haddon and Mr. A. D. Hall (president of the agricultural section) it is very strongly representative of the main body.

The rest of the party, the main body, will pick up the advance party at Perth about August 7 and will sail with them for Adelaide. If it had not been for the death of Sir W. H. White, who was to have been president at Birmingham last year, Sir Oliver Lodge would have been the president for the Australian meeting; and Australia has been eager to welcome him in his presidential capacity. Consequently he has been asked to deliver an address, and has consented. At Adelaide he will speak at an evening meeting on "The Ether of Space," and this valedictory discourse will embody his conclusions as to the objective reality of this concept, and his criticisms of the new mechanics by which an attempt is being made to replace it. Dr. W. J. Sollas, of Oxford, will deliver the other evening discourse on "Ancient Races and Their Modern Representatives"—of whom he believes the extinct Tasmanians to have been the most primitive—and Sir Charles Lucas and Mr. A. D. Hall will address their sections of geography and of agriculture.

From Adelaide, after a stay of four days, the association will go on to Melbourne, which with Sydney will be the auditorium of the larger part of the addresses, papers and discussions. Following the precedent of South Africa, the presidential address of Professor Bateson will be divided into two parts. The address in Melbourne will discuss the problem of evolution in the light of Mendelian discoveries. Professor Bateson will especially attempt a consideration of the nature of variation, showing the extreme difficulty of any longer maintaining the received doctrines on these subjects. At Sydney he will proceed further to show the application of the results of Mendelian analysis to man, pleading for simpler views of life and death and for a fuller recognition of biological knowledge in regard to conduct and the ordering of social structures.

The president's address will be delivered on the evening of August 14, and on that morning and on two other days the sections of mathematics, chemistry, zoology, economics and physiology will meet. When the association is adjourned and meets again in Sydney (August 20) the second part of the presidential address will be delivered and the remaining sections of geology, engineering, anthropology, botany and education will assemble. In another week the members move on again to Brisbane, where the sections of physiology and agriculture reassemble and where an address will be delivered by Professor W. E. Brown on "Cosmical Physics." These addresses and evening lectures are a special characteristic of the meeting, and among those who deliver them will be Sir E. A. Schafer on "The Origin of Life," Sir E. Rutherford, Professor Elliot Smith, Professor N. E. Armstrong, Professor E. B. Poulton, Professor G. W. Howe, Professor H. H. Turner, Professor B. Moore and Dr. Rosenhain.

After leaving Sydney some of the members of the association will visit New Zealand, and others will go to Tasmania. After the concluding meeting at Brisbane some will return directly home, but a number, splitting into larger or smaller parties, will continue the program of excursions which are so liberally provided for in the program of the month's meeting. One party, for example, will travel across North Queensland, others will visit New Guinea, where the commonwealth government has placed a yacht at the disposal of a specific anthropological investigation; and there are many other excursions for those who have time to make them before returning home by way of New Guinea and Java.

SCIENTIFIC NOTES AND NEWS

WITH the close of the present term at the Massachusetts Institute of Technology, Professor Robert H. Richards will retire from the active work of teaching which he has followed for forty-six years. He is made professor emeritus and receives the benefits of the Carnegie Foundation. Professor Richards has

been identified with the institute since its beginning, he was a student in the first class and a graduate in the first group to receive the B.S., following which he became assistant—1868–1871—and then in 1871 took the chair of mineralogy, in the department that afterwards developed into that of mining engineering and metallurgy.

PROFESSOR JOHN PERRY has recently retired from the staff of the Imperial College of Science and Technology, and a fund is being raised for the purpose of giving expression to the appreciation of his services to the teaching of mathematics and to engineering education.

THE astronomer royal, Mr. Frank Watson Dyson, has been elected Halley lecturer at the University of Oxford for next year.

LORD LAMINGTON has accepted the office of president of the Research Defence Society, in the room of the late Sir David Gill.

THE honorary degree of doctor of engineering has been conferred upon Commerzienrat Carl Paul Goerz, the head of the Goerz Optical Works, by the Technical High School in Charlottenburg.

DR. SMITH ELY JELLIFFE, of New York City, has been elected a corresponding member of the Paris Neurological Society.

PROFESSOR GEORGE C. WHIPPLE, of Harvard University, has been chosen as one of three American engineers to act with three Canadian engineers to advise with the International Joint Commission on matters pertaining to the pollution of the Great Lakes. Professor Whipple has also been chosen a member of a commission consisting of five sanitary engineers to advise the commissioner of health of New York State on matters pertaining to the location of tuberculosis hospitals on catchment areas used for public water supplies.

DR. C. E. MENDENHALL, professor of physics at the University of Wisconsin; Dr. Knight Dunlap, associate professor of psychology at the Johns Hopkins University and Dr. W. E. Burge, assistant professor and acting head of the department of physiology at the University of Illinois, have accepted invitations to carry on research work during the coming summer in Nela Research Laboratory (formerly known as Physical Laboratory, National Electric Lamp Association). Dr. Willibald Weniger, of the Oregon Agricultural College, has also been secured for special research work during the summer and Mr. A. F. Wagner, of Purdue University, has been appointed to a temporary assistantship in the laboratory for a part of the vacation period.

AN exhibition of photographs by Mr. A. Radclyffe Dugmore, the African traveler and author of works on photographing big game in their native haunts, is being held at the house of the Royal Photographic Society, London.

PROFESSOR MARSHALL H. SAVILLE, of Columbia University, has sailed for Colombia, to make archeological explorations there and in Equador.

DR. J. N. ROSE, research associate in the Carnegie Institution of Washington, left New York on June 10 for the west coast of South America, where he goes under the auspices of the Carnegie Institution of Washington and the New York Botanical Garden, for the purpose of making a special study of the Cacti of the deserts of Peru, Chile, Argentina and Bolivia. He expects to send large collections of living plants to the New York Botanical Garden. He will be absent from Washington between four and six months.

PROFESSOR ALBERT JOHANNSEN, of the University of Chicago, has sailed for Europe to spend the summer in the mineralogical laboratories of Germany and Austria.

SIR ERNEST SHACKLETON with nine members of his expedition have visited Norway to test provisions and motor-sledges for his forthcoming Antarctic expedition.

AT Cornell University officers of Sigma Xi have been elected for the ensuing year as follows: *President,* Professor A. W. Browne, department of chemistry; *Vice-president,* Professor J. G. Needham, department of biology; *Counsellor,* Professor D. S. Kimball, Sibley College; *Recording Secretary,* Professor F. K. Richtmyer, department of physics; *Corre-*

sponding Secretary, Professor James McMahon, department of mathematics; *Treasurer,* Professor W. A. Riley, department of biology; *Program Committee,* Professor H. N. Ogden, civil engineering; Professor H. S. Jacoby, civil engineering; Professor A. W. Gilbert, department of plant breeding, and Professor A. W. Browne, *ex-officio.*

PROFESSOR W. M. DAVIS gave a lecture in the Town Hall at Suva, Fiji, on April 30, on "The Origin of the Coral Reefs of Fiji," in which he presented the chief results of his seven weeks' visit to those islands as a part of his Shaler Memorial study of coral reefs in the South Pacific. On May first he left for New Zealand.

ON May 25 Professor M. A. Rosanoff, of Clark University, presented before the research staff of the Mellon Institute, University of Pittsburgh, a theory of the mechanism of sugar inversion by acids.

DR. AMOS LAWRENCE MASON, senior physician of the Boston City Hospital and formerly associate professor of clinical medicine at the Harvard Medical School, has died at the age of seventy-two years.

THE death is announced of Miss Ida Freund, late lecturer in chemistry at Newnham College, Cambridge.

MR. WILLIAM WEST, lecturer at the Bradford Technical College, known for his contributions to botany, died on May 14, aged sixty-eight years.

Le Figaro for May 9 contains an announcement of the death of the noted French mathematician Jules Molk, who is especially well known to American mathematicians as the principal editor of the French edition of the large mathematical encyclopedia, which is now being published jointly by Gauthier-Villars of Paris and B. G. Teubner of Leipzig.

THE U. S. Civil Service Commission announces an examination for assistant biochemist in the U. S. Public Health Service, for duty in the field, at $2,000 a year, and for assistant mining engineer, in the Bureau of Mines, for service in the field, in relation to coal mining or metal mining, at salaries ranging from $1,800 to $2,400.

ON the afternoon of May 23, a conference was held at the Brooklyn Botanic Garden between the garden staff and the high school teachers of biology of Greater New York, as represented by the New York Association of Biology Teachers. The purpose of the conference was to offer an opportunity for the members of the association to become better acquainted with the aims, equipment and work of the garden, and to enable the latter to secure from the teachers practical suggestions as to how the garden may render the largest service to the teaching of botany in New York City and vicinity. The program was as follows:

What the garden can offer the schools.
- The director of the garden.
- The curator of public instruction.
- The instructor.

High school classes at the garden.
- The teachers of classes that have used the garden.

Suggestions from teachers.
- Open discussion led by the president of the New York Association of Biology Teachers.

Following the conference there was an inspection of the first section of the laboratory building and the first two sections of the conservatories. The second section of the conservatories devoted to tropical economic plants was opened to visitors for the first time on this occasion and will hereafter be open to the public daily.

THE Harpswell Laboratory will be open for its fifteenth season from June 21 to the middle of September. It is intended to offer to investigators an opportunity to study a more northern fauna and flora than any other station in the United States. Though the laboratory is small, it has a good equipment, sufficient for any ordinary investigations. Its location, at South Harpswell, Me., on the shore of Casco Bay, assures abundant material for various lines of biological investigation, as well as a most comfortable summer climate and fine natural scenery. During the past some seventy higher institutions of learning have

been represented by workers there and a considerable amount of material has been published, based wholly or in part of investigations carried on there. This year it will be under the control of Drs. Neal and Kingsley, who have carried it on for several years, and all inquiries concerning rooms and other accommodations should be directed to Dr. H. V. Neal, Tufts College, Mass., until June 17; after that date to him at South Harpswell, Me. The laboratory, at most, can accommodate but fifteen workers at a time, and already considerable part of its space is engaged for at least a part of the summer.

It is announced that the biological laboratory of the United States Bureau of Fisheries at Fairport, Iowa, will be opened for investigators on June 15, and is expected to remain in active operation until about September 1. Those desiring to have the use of tables and other facilities for investigation may communicate with the commissioner of fisheries, Washington, D. C., or with the director of the Fairport station, Fairport, Iowa. The station is well equipped with laboratory and collecting apparatus, as well as with ponds and tanks, and supplies of river water and filtered water.

Wilhelm Engelmann, of Leipzig and Berlin, announces the publication of the *Internationale Zeitschrift für physikalischechemische Biologie*. The editor is Dr. J. Traube, of Charlottenburg, with the assistance of Professor H. J. Hamburger, of Gröningen, Dr. V. Henri, of Paris, and Dr. J. Loeb, of the Rockefeller Institute for Medical Research, New York. The periodical will appear at irregular intervals, six parts forming a volume. It is hoped that about three volumes will be issued in the course of the year.

Dr. von Le Coq, the distinguished explorer, has promised, as we learn from the London *Times*, to lecture on his recent tour in Chinese Turkestan before the Royal Asiatic Society in the autumn. Writing from Berlin a few days ago he states that the results of his last journey have been very satisfactory, both in quality and quantity. His collections fill 152 cases. He worked mainly at Kucha and at Tumshug, near Maralbashi. At Maralbashi he found a number of true Gandhara sculptures, some being exact counterparts of sculptures in slate in existing collections. But the finds, instead of being carved from Himalayan slate, were moulded in clay and plaster, some of the moulds being found alongside. Many of the "sculptures" were still covered with paint and gold leaf. He also discovered manuscripts, the first, it is believed, ever found at Tumshug. Some of these were in Sanskrit, and others, perfectly preserved, in an Iranian language. Other finds were a small but fine cornice, decorated in pure Sassanian style, and a number of heads of Sassanian knights; some good bronzes and statuettes in wood.

The national forest reservation commission has approved the purchase of the Pisgah Forest from the estate of the late George W. Vanderbilt, at an average price of five dollars an acre. The tract consists of 86,700 acres and the total cost is therefore $433,500. The price paid is less than the average for other tracts already acquired, although the Pisgah Forest has been developed by its former owner into one of the best forest properties in the country. This is the second time that the commission has had the purchase of this tract under consideration. Once before, during Mr. Vanderbilt's lifetime, the question of its purchase was taken up, but the commission did not deem it advisable to purchase it at that time. The tract includes portions of Transylvania, Henderson, Buncombe and Hayward counties, in North Carolina. It covers the entire eastern slope and portions of the northern and western slopes of the Pisgah range, one of the most prominent of the southern Appalachians. Its forests influence for the most part tributaries of the French Broad River which unites with the Holstein River at Knoxville, Tennessee, to form the Tennessee River. In accordance with Mrs. Vanderbilt's desire, the national forest reservation commission will retain the name of "Pisgah Forest"; in fact, the general area, in which this forest is located and in which other purchases may be made, is already designated as the "Pisgah Area." It is proposed

also to make it a game refuge for the preservation of the fauna of the eastern mountains. It is particularly well suited to this purpose since it is already well stocked with game and fish, including deer, turkey and pheasant; and in the streams rainbow trout and brook trout, with which they have been systematically stocked from year to year. With this purchase, and with others just approved, the total area approved for purchase under the Weeks law in the eastern mountains is 1,077,000 acres.

FACTS regarding our forest resources, their value and their waste, are condensed in an eight-page illustrated circular of the American forestry association just issued. The lumber industry is said to employ 735,000 people, to whom are paid annually $367,000,000 in wages, the worth of products being $1,250,000,000. The forests of the country cover 550,000,000 acres. An average of 70 human lives are sacrificed annually in forest fires, says the circular, and a loss occurs of $25,000,000. Damage from insects and tree diseases, which follow fire, costs each year $50,000,000. The cost of destruction resulting from floods is not estimated, but is given as "countless millions." But the circular expresses hope more than pessimism. As well as the colored pictures showing the forest fire, the effects of the fire, and the damage caused by floods, it shows also forests planted and grown under intensive management, and the national forest ranger scouting for fires on the mountain lookout station. The effective patrol here referred to has reduced "forest fire losses to as low as one tenth of one cent an acre." It is pointed out that by planting forests an annual income could be derived in the country of $65,000,000; and by preservative treatment upon timber each year $100,000,000 could be saved.

THERE has recently been established in Nela Research Laboratory (formerly known as Physical Laboratory, National Electric Lamp Association) a section of applied science in addition to the section of pure science which was established over five years ago. The section of applied science will be separate and distinct from the section of pure science and will not restrict or in any way affect the established work in pure science. A research fellowship in ophthalmology in Nela Research Laboratory has been established for the year 1914–15. The fellowship carries with it an honorarium of $700 and is open to men sufficiently advanced in specialized medical training to carry on an independent investigation of some problem having to do with the effects of light and attendant radiation on the eye.

WE learn from *Nature* that the movement inaugurated a few months ago to develop as completely as possible the educational side of the kinematograph made definite headway on Wednesday, May 20, when the Educational Kinematograph Association was formed at a meeting in London. Among those who have joined the council of this body are Sir H. A. Miers, Rt. Hon. Sir Horace Plunkett, Dr. C. W. Kimmins, Professor R. A. Gregory, Professor J. W. Gregory, Mr. C. Bathurst, M.P., Dr. Lyttelton, Mr. A. P. Graves, Professor Darroch, Sir Edward Anwyl, Sir Harry R. Reichel, Sir Bertram Windle, Sir Albert Rollit and General Sir R. Baden Powell. At the meeting a report was presented by the secretary, Mr. Morley Dainow, on behalf of the provisional committee, suggesting that the work of the association should be to encourage the best types of kinematograph production and develop a completely educational plan for their use. The report was adopted, subject to revision by a subcommittee. The following officers were elected vice-presidents: Sir Wm. Chance, Dr. Kimmins, Colonel Sir J. R. D. Smith, Sir Albert Rollit. An executive committee representative of educational and social welfare associations was also appointed, and Mr. Morley was elected secretary.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ANDREW CARNEGIE has added, presumably from the income of the Carnegie corporation, $2,000,000 to the endowment of the Carnegie Institute of Pittsburgh, to be equally divided between the institute and the school

of technology. Mr. Carnegie's gifts to these institutions now amount to $24,000,000.

By the will of former Judge John Forrest Dillon, Iowa State University receives $10,000 and Iowa College and Cornell College, $1,000 each.

An additional gift of $25,000 has been received by Oberlin College for carrying out the general building plans and the improvement of grounds.

The alumni of the University of Illinois are planning to erect a $150,000 building as a memorial to John Milton Gregory, first president of the university. It is to house an art collection gathered by Dr. Gregory and a new collection of figures and panels which the alumni association intends to buy.

The Arnold Biological Laboratory, ground for which has been broken at Brown University, is expected to be finished a year from this summer. The building itself will cost $80,000, while $30,000 more will be spent upon the equipment.

The Drapers' Company has made a grant of £200 a year for three years for anthropology at the University of Cambridge.

Last year Sir William James Thomas, of Ynyshir, undertook to build and present to the University College of South Wales and Monmouthshire on a site contiguous to the old buildings in Newport Road a complete physiological department, so constructed as to form a part of a scheme for a complete medical school on the same site. Now, as we learn from *Nature*, a donor, who wishes at present to remain anonymous, has offered to build the whole of the buildings necessary not only for a medical school, but also a school of preventive medicine, at an estimated cost of £60,000. One of the conditions attached to the latter gift, however, is that the funds supplied by the treasury should be sufficient for the upkeep of the complete school.

Central Turkey College at Aintab has received from the Turkish government official recognition as *école superieure*. It is the first of the American colleges in Turkey to secure such authorization for any part of its regular curriculum.

Mr. Albert L. Barrows has been appointed instructor in zoology in the University of California.

Dr. Thomas H. MacBride, professor of botany, has been appointed president of the Iowa State University by the State Board of Education.

DISCUSSION AND CORRESPONDENCE

THE ORGANIZATION OF A UNIVERSITY DEPARTMENT

To the Editor of Science: I have read with interest the letter of Professor F. L. Washburn on "Heads of Departments," in Science of May 1; and it has occurred to me that your readers might be interested in an account of the present organization of one of the largest departments in one of the largest universities in America.

At Columbia University a department of English was first established in 1899 by assigning to it the professor of English literature, the professor of dramatic literature and the professor of rhetoric and English composition; and these three thereupon organized by inviting the professor of English in Teachers College to join them and by electing the professor of English literature as chairman and the professor of rhetoric as secretary. On the death of the professor of English literature, the late Thomas R. Price, the position of chairman was abolished, the senior professor of the department being expected to preside at its meetings and all the administrative duties being confided to the secretary, who was relieved of a part of his teaching that he might be enabled to carry this extra burden.

With the expansion of Columbia University and of its several colleges and schools, Columbia College, Barnard, Teachers and the School of Journalism, the department of English has grown in numbers; and several years ago the department of comparative literature was merged with it, so that it now consists of more than twenty professors, assistant professors and associate professors. And during the past fifteen years it has administered its

own affairs in town-meeting, so to speak, as an absolute democracy, in which every member has an equal voice. It has made all nominations; it has recommended all promotions; and it has requested all increase of salary; and in every case its nominations and recommendations have been favorably received by the president and by the trustees, who have granted all our requests—excepting only those not at the moment financially advisable.

Almost every member of the department serves on one or more of the special committees, to whom we confide the oversight of our several activities. Whenever we have felt the need of developing instruction in any part of our field, we have never had to draft a man for service, for all have been ready to volunteer for duty. As a result of this harmony every part of our work—graduate and undergraduate, in college and in school, and in the extension courses—has been coordinated in response to our individual and united understanding of the demands of the occasion. And so complete is this harmony, that since the department was established, no action of any kind has been taken and no recommendation has been made, other than by a unanimous vote.

BRANDER MATTHEWS

COLUMBIA UNIVERSITY,
IN THE CITY OF NEW YORK,
May 14, 1914

THE NEW FUR SEAL INVESTIGATION

THE present Commissioner of Fisheries and Secretary of Commerce, having grown distrustful of past investigators, have arranged for a new fur-seal commission for the season of 1914. To those who have followed the fur-seal situation in the past few years this is a disappointment, delaying as it does for one season more the emancipation of the herd. Without wishing to prejudice the work of the new commission, but in simple justice to those whose work is thus put on trial, it seems fair to point out certain phases of the situation which confronts the new investigators.

By the law of 1912 commercial killing of fur seals is prohibited for five years. The object of any investigation at the present time must be to determine the wisdom or unwisdom, the necessity or lack of necessity, of this law. In effect the law was condemned eighteen years ago by the joint commission of American and British experts of 1896–7. The following words from the ninth paragraph of their joint agreement are worth quoting:

> The methods of driving and killing practised on the islands, as they have come under our observation during the past two seasons, call for no criticism or objection. An adequate supply of bulls is present on the rookeries; the number of older bachelors rejected in the drives during the period in question is such as to safeguard in the immediate future a similarly adequate supply; the breeding bulls, females, and pups on the breeding grounds are not disturbed; there is no evidence or sign of impairment of virility of males; the operations of driving and killing are conducted skillfully and without inhumanity.

This very positive conclusion was reached after two seasons of thorough study, involving the observation and inspection of drives aggregating 150,000 animals, 50,000 of which were killed. The commission of 1914 will have no opportunity whatever to observe the normal methods of land sealing, the law preventing it. The commission of 1896–7 had opportunity to carefully weigh and consider the action of pelagic sealing, in its judgment the sole cause of the herd's decline, determining the proportion of pregnant and nursing females in the catch on board the sealing vessels and observing the starvation of the dependent young on land. The new commission is entirely cut off from this source of information, the treaty of 1911 having suspended pelagic sealing. The new commission can obtain definite information from the rookeries of the present condition of the herd, but it will have no basis of comparison arising from previous experience, and can not, therefore, of itself determine whether the herd is increasing or diminishing.

Another difficulty confronts the new commission. It is said to "have been selected by outside agencies and to have no previous connection with the fur seal controversy." In other words it is a non-partisan commission.

The Secretary of Commerce has, however, taken pains to show that the issue is by no means a non-partisan one. On October 13, 1913, Secretary Redfield appeared before the House Committee on Expenditures in the Department of Commerce and thus expressed himself regarding the law of 1912: "I shall be glad to cooperate in any way within my lawful power or within the scope of my personal ability in carrying out to the spirit and to the letter what I regard as very wise legislation for the protection of our fur-seal herd." He even went further and announced to the committee that he had discharged the chief of the Alaska division of the Bureau of Fisheries and the naturalist of the fur-seal herd, because, forsooth, their "mental attitude" toward this law was not right. In other words, because these men believed the law was a mistake, they were disciplined.

The new commission is therefore in a dilemma. It must find the law of 1912 to be right or else to be wrong. In the one case, in a single season's work and with opportunity to get first-hand information on vital matters cut off, it must either review and turn down the work of an eminent body of men acting on unlimited data, or else it must contradict the expressed belief of the very authority under which the commission acts.

Meanwhile there hangs over the commission and its work a most heavy forfeit. The law of 1912, in so far as it prohibits the killing of male seals, was adjudged unnecessary eighteen years ago; the increase of 12½ per cent. in the stock of breeding seals in 1913, the second season under exemption from pelagic sealing, fully bears out this decision. The Secretary of Commerce has in his possession to-day adequate data to warrant the immediate repeal of the law. Such repeal now would permit of the resumption of normal land sealing in 1914 and the taking of the half million dollars' worth of sealskins which the hauling grounds of the Pribilof Islands stand ready to yield. We lost a like sum in 1913 through the operation of the law. The delay necessary to let the new commission make its report will inevitably repeat this loss. In short, the report of the commission will cost at a minimum $500,000, fifteen per cent. of which belongs to Canada, fifteen per cent. to Japan, and seventy per cent. to the treasury of the United States, under the treaty of July 7, 1911.

George Archibald Clark

THE PRESERVATION OF ANTHROPOID APES

To the Editor of Science: The suggestion of Professor Robert Yerkes in Science of May 1, that permanent stations should be established in tropical countries for the preservation of anthropoid apes in order that observations of value from a psychological standpoint be obtained, prompts me to urge the same thing on another and more important ground. As readers of Science doubtless know, the question of the etiology and the treatment in a number of diseases which have hitherto baffled investigators, probably will depend upon the use of these apes as objects of experimentation, and for this, if for nothing else their extinction should be prevented.

H. Gifford

Omaha, Neb.

SCIENTIFIC BOOKS

Clean Water and How to Get It. By Allen Hazen. Second Edition. New York, John Wiley & Sons. 1914. Pp. 181. $1.50.

Studies in Water Supply. By A. C. Houston. New York, Macmillan Co., Limited. Pp. 193. $1.60.

These two volumes may well be considered together, for they occupy the same general field, although their scope and method of treatment are quite different. Both authors are acknowledged experts in the subjects with which they deal.

Hazen's book is decidedly American in point of view and makes a strong case for the filtration of public water supplies as a means of protecting municipalities against typhoid and other forms of disease and for the improvement which can be so produced in the appearance, taste and odor of surface waters.

By some, the book will be regarded as too condensed to give a comprehensive knowledge of the many topics dealt with, but the

volume is not intended to be exhaustive. It is such a statement of the essential principles of American water purification practise as Mr. Hazen's large experience as a consulting engineer in this field has led him to believe would be useful to beginners. There is no better text-book for persons desiring a knowledge of water purification in the United States.

There are eighteen chapters in Mr. Hazen's book, including such topics as water supplies from rivers, lakes and wells; the history of water purification in the United States; storage of filtered water; use and measurement of water; suitable pressure to be supplied in water works systems; effect of iron pipes on water, and the layout of works. The subjects dealt with include sand filters, mechanical filters, coagulation basins and aeration.

The book is well-illustrated with half-tones and is produced with the usual excellence of the Wiley press. The first edition, published seven years ago, has been revised and expanded.

Houston, the bacteriologist and director of water examination of the Metropolitan Water Board of London, has produced a book in which he has explained his views as to the extent of the danger to be apprehended from polluted river water and how that danger is avoided without filtration by London, the largest and one of the healthiest cities in the world.

The American arguments which have been built up without opposition in the last twenty years and which seek to account for much of the excessive prevalence of typhoid in American cities as caused by polluted surface water are declared to be inconclusive and not in consonance with ascertainable facts.

Dr. Houston maintains that a watershed may be exposed to manifold pollution and the river draining from it impure, as judged by ordinary chemical and bacterial tests, but the water may nevertheless be shown to contain none, or scarcely any, of the microbes of water-borne diseases when tested by methods of proved value.

The American theory to the effect that the incidence of tuberculosis, pneumonia and other diseases not otherwise suspected of being water-borne can be greatly reduced by improving a public water supply is incredible to Dr. Houston.

The book is actually, but not formally, divided into two parts: The first tends to free the River Thames and the River Lee, which supply London with 80 per cent. of its drinking water, from the full gravity of the charge of being sewage-polluted rivers, and the second presents evidence that the self-purification process employed by London to prepare the water for consumption is uniformly efficient. There are eleven short chapters. The topics include water and disease; the financial value of pure water; sterilization processes; storage in relation to purification; the question of abstraction; sources of water; bacterial methods and much information about the remarkable water supplies for London over whose quality the author has had official supervision for many years.

GEORGE A. SOPER

NEW YORK CITY

Studies in Seeds and Fruits. An Investigation with the Balance. H. B. GUPPY. London: Williams and Norgate. 1912. Pp. xii + 528.

A careful reading of the research work, detailed in this volume, has abundantly repaid the reviewer. Guppy commenced the investigation, as a study of the rest-period of seeds, using in his research merely a sharp knife, pocket lens, balance and oven. The first chapter details the history of the investigation. The second chapter describes the three conditions of the seed, viz., the soft pre-resting seed, the contrasted, hard-resting seed and the soft, swollen seed on the eve of germination. Observations by means of the balance are made on seeds in all three of these stages. The third chapter is concerned with the impermeability of seeds and its significance, the fifth is a classification of seeds according to their permeability, or impermeability, while the sixth chapter gives additional evidence. The whole book is full of tables and is loaded with

detailed observations on such subjects as hygroscopicity, the régime of the shrinking and swelling seeds, the dehiscence of fruits, the proportion of parts in fruits, the abortion of ovules, seed coloration, the weight of the embryo, the rest-period of seeds and a philosophic chapter (XX.) on the cosmic adaptation of the seed in which the author states his belief that the seed is less specialized and less conditioned than the plant; that its potentialities present us with a range of life-conditions that extends beyond the earth and offers a clue to the conditions of existence in other worlds. Finally Guppy postulates a flora of the cosmos.

Although the author allows himself in the last chapter to be spirited away from things mundane, yet, the whole work is pervaded with the spirit of thorough scientific research in which no fact is overlooked which might bear on the main problem of seed investigation, and each fact is submitted to rigid examination, by the balance and other instruments of precision. The book has been overlooked apparently by other American botanic reviewers and it deserves a place on the shelves of any library that attempts to be stocked with recent important contributions to botanic science.

John W. Harshberger
University of Pennsylvania

SPECIAL ARTICLES

A NEW MARKING SYSTEM AND MEANS OF MEASURING MATHEMATICAL ABILITIES[1]

Perhaps the most noted methods of measuring the intelligence of young children are the De Sanctis and the Binet-Simon tests. These tests apply mainly to the measurement of lower levels of intelligence. It is very significant that the noted Italian and French psychologists who originated these tests did not extend the general method to be used with pupils of the secondary and higher schools. In the present state of educational psychology it does not seem practicable or possible to effect successfully such an extension; that is to say, it is improbable that such tests can be devised which can be applied to everyday use in our schools, and will be a real improvement upon our present system of examinations, in settling questions of promotion and in awarding honors in our high schools and colleges. We are able to determine certain questions of athletic proficiency by measuring the high jump or broad jump, by timing the quarter-mile or half-mile run. The fact that the candidate knows beforehand the nature of the test does not materially interfere with its efficiency. But if a candidate for promotion knows beforehand the exact nature of the test in algebra—as he easily may know, if tests are adopted to be used by all teachers at all times—then he can easily learn the few tests and make a high grade, even though his knowledge of the entire subject may be woefully deficient. It is quite evident that it is impossible to formulate specific questions in any branch of high-school mathematics, which could be used everywhere and at all times. Yet the report of the American Committee No. VII. on Examinations in Mathematics contains the following:[2]

> There seems to be a pronounced desire throughout the country for standardized tests in mathematics, that is, tests which will enable teachers to measure fairly accurately the efficiency of their instruction and to know whether their pupils are as proficient as those in other localities.

One way to meet this demand is to prepare a syllabus of essentials in high-school arithmetic, algebra and geometry, to be used in preparing the specific questions for an examination. Such a syllabus has its merits and also its demerits. Its merits are that both teachers and pupils have the territory to be covered by the examination more definitely limited to what are the essentials. Its demerits are that it leads both teachers and pupils to a disregard of the many minor facts of a science, which deserve at least passing notice.

[1] Read before the mathematics section of the Central Association of Science and Mathematics Teachers, November 29, 1913, at Des Moines, Iowa.

[2] U. S. Bureau of Educ., *Bulletin*, 1911, No. 8, p. 13.

Nor does the use of such a syllabus prevent the selection by one teacher of only easy exercises, and by another teacher of only hard exercises. It is my opinion that the value of a syllabus is overestimated, that our high-school text-books do not differ widely in the amount of material, nor in the degree of difficulty of the exercises contained therein. If a teacher carefully prepares a set of questions which, taken as a whole, are of average difficulty, he may rightly assume that he has a standard test. Notice my use of the word "carefully." No system of marking, however perfect, can be successful, if the teacher does not exercise *care*. A 12-inch disappearing gun will not defend Panama unless there is a careful eye to train it.

Granted that a standard set of questions is at hand, are our difficulties solved? Have we an absolute system of marking? By no means. Every one knows that two teachers seldom agree on the marking of the same examination paper. They differ often by 10 or 20, and sometimes even by 30 points on the scale of 100. Suppose a pupil in algebra makes a mistake in algebraic sign, but otherwise answers a question correctly. One teacher will attribute the error to mere oversight, and mark the question nearly perfect. Another teacher will be horrified at the ignorance of fundamentals, and will mark the same question nearly 0. Such discrepancies will arise even in the use of the Binet-Simon system. That system does not eliminate the lopsidedness of the examiner. One of the questions put to a child of ten is this: "What would you do if you were delayed in going to school?" Various replies may follow, as, for instance, "I would have to hurry," "I would have to run," "I would return home," "I would be punished," "The teacher would slap me," "I would not do it again." Do you believe that in such a variety of answers which children may give, any two examiners would agree in their markings? "I would be punished" does not answer the question. Accordingly, some examiners would mark 0. Other examiners would say that the reply not only implies that the question was properly understood, but that the child's mind passed beyond the immediate reply, that it "would have to hurry," and gave expression to a possible consequence that was more remote and therefore indicative of greater intellectuality. The diversity of estimates would be as conspicuous here as in any ordinary examination. As yet we are as far as ever from an accurate standard of marking.

But a more or less absolute standard of marking is the very thing we are after. We need a common mode of procedure, such that a mark of "excellent" in first-year geometry, given by a teacher this year, means nearly the same thing as a mark of "excellent" in this subject that will be given by a teacher twenty years from now. We need a system of marking such that a mark expressed in numbers conveys to every one a fairly uniform and definite idea of proficiency. During the last few years great progress has been made in devising plans toward achieving this end. What I shall present to you to-day contains little that is novel. In this matter I follow in the foot-steps of Cattell,[3] Colvin,[4] Dearborn,[5] Finkelstein,[6] Foster,[7] Hall,[8] Herschel,[9] Huey,[10] Judd,[11] Meyer,[12] Sargant,[13] Smith,[14] Steele,[15] Stevens,[16] Starch[17] and others.

[3] J. M. Cattell, *Popular Science Monthly*, Vol. 66, 1905, p. 367.

[4] S. S. Colvin, *Education*, Vol. 32, 1912, p. 560.

[5] W. F. Dearborn, *Bulletin of the University of Wisconsin*, 1910, No. 368.

[6] I. E. Finkelstein, "The Marking System in Theory and Practice," 1913.

[7] W. F. Foster, SCIENCE, Vol. 35, 1912, p. 887; *Popular Science Monthly*, Vol. 78, 1911, p. 388; "Administration of the College Curriculum," 1911, Chap. 13.

[8] W. S. Hall, *School of Science and Mathematics*, Vol. 6, 1906, p. 501.

[9] W. H. Herschel, *Bull. of Soc. from Prom. of Engineer. Education*, Vol. 3, 1913, p. 529.

[10] E. B. Huey, *Journal of Psycho-Asthenics*, Vol. 15, 1910, p. 31.

[11] C. H. Judd, *School Review*, Vol. 18, 1910, p. 460.

[12] M. Meyer, SCIENCE, Vol. 28, 1908, p. 243; Vol. 33, 1911, p. 661.

[13] E. B. Sargant, *Nature*, Vol. 70, 1904, p. 63.

[14] A. G. Smith, *Journal of Educational Psychology*, Vol. 2, 1911, p. 383.

Our scheme of measuring mathematical abilities resolves itself into two parts, as follows:

1. A formula for "arraying" students in order of ability, that is, for determining the relative positions of the members of a class, so as to establish the order of merit, or the rank of each individual in the group. This formula furnishes also preliminary estimates of ability.

2. A revision of these preliminary estimates so as to supplant them by an absolute standard.

Part I

Mathematical ability depends in part upon knowledge of a subject and proficiency in carrying on accurately the mechanical operations connected with it. This kind of ability may be determined by the usual memory tests conducted from day to day in the class-room, and at longer intervals by examination.

Mathematical ability is measured also by the success in solving original exercises. These tests are made in daily work, and also in final examinations.

The observation of instructors and the teachings of the history of science suggest a still further test of mathematical power, namely, the diligence or tenacity displayed by a pupil in pursuing his work. A pupil of only average talents, but of great tenacity of purpose, may achieve more in his life than a bright pupil of limited powers of application. A standard illustration is the case of Robert Mayer, who as a pupil made only a moderate record, but who, by his extraordinary tenacity of purpose was led to the discovery of the law of the conservation of energy.

In Germany and Switzerland this feature is being recognized in the records and reports of scholarship. When I was a boy I received two marks on every subject, one for *Fleiss*, or diligence, the other for *Fortgang*, or progress. In Germany this practise is in vogue to-day.

According to our scheme, the mathematical pupil is measured in three ways, as follows:

1. By memory tests
   (*a*) In daily work.............. Ma
   (*b*) In examination............ Mb
2. By original exercises
   (*a*) In daily work.............. Oa
   (*b*) In examinations............ Ob
3. By diligence (tenacity) shown.... D

How these marks should be combined might be a subject of legitimate debate. Following custom, we use the weighted arithmetic mean, as follows:

$$\text{Preliminary Mark} = \frac{M_a + rM_b + sO_a + tO_b + uD}{1 + r + s + t + u}$$

where r, s, t, u are coefficients determining relative weights. What weight should be given to daily work, what to the examination? In different schools the weights vary from daily work $\frac{2}{3}$, final examinations $\frac{1}{3}$, to daily work $\frac{3}{4}$ and final examination $\frac{1}{4}$. A conservative estimate would be to take $s = 1$, $r = t = u = \frac{1}{2}$.

Part II

After the relative place or rank of the students in a class has been determined by the process of Part I., we proceed to determine their marks on an absolute scale. We shall assume that the pupils constitute a random sample or "fair sample" of the student body. What is the distribution of mental ability, and of mathematical ability in particular? No one has been able to give a final answer to this question. Francis Galton, Karl Pearson and others have held that individuals differ from each other in ability in such a way as to conform with what is known as the "normal frequency curve" or the "normal curve" or the "Gaussian curve." Distances along the horizontal line measure the students' abilities. The corresponding ordinates of this bell-shaped curve indicate the frequency. In measuring physical characteristics, it is easy to tell whether or not the above curve represents the proper distribution. It is a singular fact that this curve has been found to represent a general biological

[15] A. G. Steele, *Pedagogical Seminary*, Vol. 18, 1911, p. 523.

[16] W. L. Stevens, *Popular Science Monthly*, Vol. 63, 1903, p. 312.

[17] D. Starch, *Psychol. Bulletin*, Vol. 10, 1913. p. 74; Science, Vol. 38, 1913, p. 630.

law of variation. Natural phenomena, as well as chance, tend to fluctuate in a manner indicated by this curve. Chest measurements on 5,738 soldiers[18] show the close agreement with theory. The stature of 1,052 English women[19] was found by Karl Pearson to closely obey the Gaussian law. Some of the lower mental traits can be measured in the psychological laboratory. Thorndike[20] found twelve-year-old pupils to be distributed according to the Gaussian curve as regards their accuracy and rapidity of perception. Memory tests yielded similar results. When it comes to tests of higher intellectual powers, records are discordant. Different examiners have varied to such a marked degree in marking the same individuals that conclusions can not be safely drawn from their estimates. On account of the presence of constant errors, the lopsidedness of individual markings can not be altogether eliminated by taking the averages of many grades from different examiners. A curve constructed from 1,487 grades in mathematics given by 19 different teachers in three high schools in Colorado exhibits two peaks with a valley between. The first peak is at 70 per cent., the passing mark; the other peak is just above 85 per cent. Evidently the peak at 70 per cent. is due to a constant error arising from the practise of raising marks of some pupils to the passing grade. Such constant errors arise also where a mark of 85 per cent. on the daily work exempts students from final examinations. It is found that in such cases medium grade students are advanced to the exempt limit. Seldom are marks given between 55 and 59, where 60 is the passing grade. If a doubtful student is finally passed, some teachers give him a mark considerably above passing, the idea being[21] that, if passed at all, he ought to be passed "handsomely." The tendency to mark high is inherent in human nature. Dr. Ruffner says:[22]

A temporizing professor who loves popularity and desires, like the old man in the fable, to please everybody, is sure to be guilty of this fault, and, like many a politician, to sacrifice permanent good for temporary favor.

For these reasons, available statistics as to the distribution of mental abilities are inconclusive. Some empirical curves indicate considerable skewness, others follow the Gaussian curve. President Foster found that 8,969 grades in 21 elementary courses for two years at Harvard obeyed the normal curve of frequency. Dearborn makes similar reports for 472 high school pupils, also for freshman grades of these same pupils at the University of Wisconsin. It is doubtless the principle of continuity that has led not only English statisticians like Galton and Pearson, but also American investigators, Foster, Meyer, Smith, Dearborn, Finkelstein and others, to aver that the Gaussian curve or normal curve is the proper curve for the distribution of marks in school. In what follows we assume that the Gaussian curve can be so used.

The question then arises, what marks should be assigned to a random group or "fair sample" of, say, twenty students, whose order of rank is known by the tests suggested in Part I. This question involves some intricate statistical theory, which has been worked out by Karl Pearson. Pearson[23] states the problem thus:

A random sample of n individuals is taken from a population of N members which when N is very large may be taken to obey any law of frequency expressed by the curve $y=N\phi(x)$, ydx being the total frequency of individuals with characters or organs lying between x and $x+dx$. It is required to find an expression for the average difference in character between the pth and the $(p+1)$th individual when the sample is arranged in order of magnitude of the character.

In answering this question, Pearson de-

[18] L. A. Quetelet, "Lettres sur la théorie des probabilités," p. 400. See also A. L. Bowley, "Elements of Statistics," London, 1902, p. 278; Dearborn, *op. cit.*, p. 8.

[19] Cattell, *op. cit.*, p. 371; Dearborn, *op. cit.*, p. 9.

[20] Thorndike, "Educational Psychology," p. 15.

[21] Finkelstein, *op. cit.*, p. 42.

[22] Quoted by Finkelstein, *op. cit.*, p. 47.

[23] Karl Pearson, "Note on Francis Galton's Problem," *Biometrica*, Vol. 1, pp. 390–399.

rives complicated formulas which we have used in calculating our data. Pearson himself felt that he had solved an important question, for he said:

AVERAGE DIFFERENTIAL ABILITIES OF PUPILS CHOSEN AT RANDOM[24]

Arbitrary Divisions	Class of 20		Class of 30		Class of 40		Class of 50		Class of 100	
	Rank	Mark/s	Rank	Mark/s	Rank	Mark/s	Rank	Mark/s	Rank	Mark/s[25]
Excellent Above +1.5	1	1.9	1	2.1	1	2.2	1	2.3	1	2.5
			2	1.6	2	1.8	2	1.9	2	2.2
					3	1.5+	3	1.6	3	2.0
									4	1.8
									5	1.7
									6	1.6
									7	1.5+
Superior +.5+ to +1.5	2	1.4	3	1.4	4	1.4	4	1.5	8, 9	1.4
	3	1.1	4	1.2	5	1.2	5	1.3	10, 11	1.3
	4	.9	5	1.0	6	1.1	6	1.2	12, 13	1.2
	5	.8	6	.9	7	1.0	7	1.1	14, 15	1.1
	6	.6	7	.8	8	.9	8, 9	1.0	16, 17	1.0
			8	.7	9	.8	10	.9	18–20	.9
			9	.6	10	.7	11	.8	21–23	.8
					11	.6	12, 13	.7	24–26	.7
					12	.6	14	.6	27–29	.6
							15	.6	30, 31	.5+
Medium −.5 to +.5	7	.5	10	.5	13	.5	16	.5	32, 33	.5
	8	.3	11	.4	14, 15	.4	17, 18	.4	34–36	.4
	9	.2	12	.3	16	.3	19, 20	.3	37–40	.3
	10	.06	13	.2	17, 18	.2	21, 22	.2	41–44	.2
			14	.1	19	.1	23, 24	.1	45–48	.1
			15	.04	20	.03	25	.02	50	.01
			16	− .04	21	− .03	26	− .02	51	− .01
	11	− .06	17	− .1	22	− .1	27, 28	− .1	53–56	− .1
	12	− .2	18	− .2	23, 24	− .2	29, 30	− .2	57–60	− .2
	13	− .3	19	− .3	25	− .3	31, 32	− .3	61–64	− .3
	14	− .5	20	− .4	26, 27	− .4	33, 34	− .4	65–67	− .4
			21	− .5	28	− .5	35	− .5	68, 69	− .5
Inferior −1.5 to −.5+	15	− .6	22	− .6	29	− .6	36	− .6	70, 71	− .5+
	16	− .8	23	− .7	30	− .6	37	− .6	72–74	− .6
	17	− .9	24	− .8	31	− .7	38, 39	− .7	75–77	− .7
	18	−1.1	25	− .9	32	− .8	40	− .8	78–80	− .8
	19	−1.4	26	−1.0	33	− .9	41	− .9	81–83	− .9
			27	−1.2	34	−1.0	42, 43	−1.0	84, 85	−1.0
			28	−1.4	35	−1.1	44	−1.1	86, 87	−1.1
					36	−1.2	45	−1.2	88, 89	−1.2
					37	−1.4	46	−1.3	90, 91	−1.3
							47	−1.5	92, 93	−1.4
Poor Below −1.5									94	−1.5+
									95	−1.6
									96	−1.7
									97	−1.8
					38	−1.5+	48	−1.6	98	−2.0
			29	−1.6	39	−1.8	49	−1.9	99	−2.2
	20	−1.9	30	−2.1	40	−2.2	50	−2.3	100	−2.5

[24] For practical use this table should be considerably extended.

[25] The marks for a class of 100 are adapted from the tables of H. L. Moore's "Laws of Wages," New York, 1911, pp. 98, 99. Moore computed his table to six decimals. He applies Pearson's statistical theory to the study of "wages and ability."

this difference problem marks a new and very probably most important departure in statistical theory.

Clearly a knowledge of the average difference in scholarship of adjacent individuals supplied by Pearson's formulas involves also a knowledge of the average difference in scholarship between any two individuals. We shall display in our tables the difference between the modal or most frequent scholarship of the class and the scholarship of any individual in the class.

The columns headed "mark/s" signify the ability of the pupil above or below the modal ability, divided by s, the standard deviation of the total group of students (say first year high school students) from which the particular class is taken at random as a "fair sample." It will be noticed that a large standard deviation indicates a large range of distribution—that is, a large difference of accomplishment between the best and poorest in the class. In freshman classes the standard deviation is apt to be large, because of great difference in preparation. For our purposes, the exact value of the standard deviation is of no interest. We are concerned more with the ratios of differential abilities than with their absolute values. Hence we shall take $s=1$, or, if more convenient, $s=10$.

Consider a class of 20 pupils. The modal or "mediocre" ability is taken here, as in the other cases, as the standard of reference and is marked 0. Abilities of students are arranged symmetrically above and below, and marked positive and negative. By subtracting the ability of a pupil of rank n from that of his neighbor below, we get the differential ability of the two. In a class of twenty the difference in average ability between the tenth and eleventh pupil is .13. The difference between the first and second pupil is .5. Thus the difference between the first and second pupils is about four times greater than the difference between the tenth and eleventh. Similar statements apply to the poorest pupil and the one next above him. These relations are brought out by the adjoining figure.

FIG. 1.

Distances measured to the right and left of the zero point signify abilities above and below the modal ability. The relative standings of the members of an average class of 20 are indicated by the dots. Observe the denseness of the dots near the modal position and the isolation of those at the ends.

When the number of pupils in a class is larger, the differential ability of the pupils ranking next to each other becomes smaller. Thus in a class of 100, the difference between the first and second is on an average .3, that between the 50th and 51st is on an average .02, but the former difference is about 15 times greater than the second. The importance of these relations is brought out by Pearson in the following words:

> It is not possible to pass over the general bearing of such results on human relations. If we define "individuality" as difference in character between a man and his compeers, we see how immensely individuality is emphasized as we pass from the average or modal individuals to the exceptional man. Differences in ability, in power to create, to discover, to rule men, do not go by uniform stages. We know this by experience, but we see it here as a direct consequence of statistical theory, flowing from a characteristic and familiar chance distribution. We ought not to be surprised, as we frequently are, at the results of competitive examination, where the difference in marks between the first men is so much greater than occurs between men towards the middle of the list. In the same way the individuality of imbeciles and criminals at the other end of the intellectual and moral scales receives its due statistical appreciation.

The total range of distribution for classes of random pupils not exceeding 100 is about $2.5s$ on each side of the modal line, where s is the standard deviation. Taking $s=1$ or $s=10$ we have a scale for marking, the objec-

tion to which lies mainly in the fact that it is new. But this scale is the most scientific yet proposed. It is based on careful, statistical theory.

The mode of distribution of mental abilities, exhibited in the normal curve, suggests that the scale be subdivided into an odd number of parts, so that there may be a central group, representing average students, which is the most common type of students. The other groups are placed symmetrically above and below this central group. What should be the total number of groups? Experience shows that three groups are hardly sufficient, that seven groups are excessive. The five-group system is altogether in nearest accord with experience. Accordingly, we shall use the terms "Excellent," "Superior," "Medium," "Inferior," "Poor," and define their positions on the Pearson scale, thus:

Poor	Inferior	Medium	Superior	Excellent
Below -1.5	-1.5 to $-.5+$	$-.5$ to $+.5$	$.5+$ to $+1.5$	Above $+1.5$

When a class of 20, 30 or 40 pupils has to be marked, we first determine the ranks of the pupils. Then the numerical values of these tables are a suggestion as to the probable marks to be assigned. For any one class of 20 these tabular figures are, of course, not binding. If a large number of different classes of 20 could be marked with absolute accuracy, the *averages* of the marks of all the pupils that take the rank n in the lists of twenties would yield the values given in the tables. Thus the averages of the students ranked fifth in different classes of twenty students each, is .8. What deviation from the tabular marks should be made in the case of any particular class because of its individual variation or its deviation from a "fair sample" must lie with the judgment of the instructor. The position of the exact line of cleavage between pupils "passing" and those "not passing" must rest with him. It is my own judgment that, *if teachers were to follow very closely the tabular marks, and were to modify them in only exceptional cases, and then only slightly, that a great stride would be taken toward a scientific and absolute method of marking.* Gross irregularities in marking, such as Finkelstein has found in Cornell, and such as we know to exist in schools with which we are connected—irregularities working great injustice to pupils aspiring to honors and to scholarships—would be eliminated by the adoption of a plan as herein set forth. Every one knows that the marking system as carried on at present in high schools and colleges is a farce. But the adoption of a scheme of marking as here proposed would show that a mark of 0 places the pupil in a modal position, as a mediocre student. A mark above 1.5 places him in the list of the very few branded "excellent." A mark below -1.5 places him near the line of students marked "not passed."

In nearly all the marking systems that have been suggested in recent years, the recommendation is made that, under normal conditions, a certain percentage of the class be marked "excellent," another percentage "superior," etc. The Missouri plan involves the same idea by dividing each class of 100 into four groups of 25 students each, and then subdividing the first and last groups again into two classes. I have never seen it pointed out that *such a procedure, as a matter of fact, rests upon an unsound basis.* The tabular data computed from Pearson's formulas show that if, for instance, we mark 7 per cent. of a class of 100 "excellent," we have a different standard of "excellence" from what we have when 7 per cent. of a class of 50 is marked "excellent." The difference in standard is slight, but it exists, and therefore renders the percentage basis scientifically objectionable. To illustrate: When 7 per cent. of the class are marked "excellent," the lower limit for this mark on the Pearson scale is (using more accurate results than those in our table) 1.4390 for a class of 100, 1.4045 for a class of 50, 1.3951 for a class of 40, 1.3529 for a class of 30, and 1.3080 for a class of 20. Seven per cent. of a class of 41 members is four, but only three of the four stand above the point 1.4390

on the Pearson scale. In other words, on the 7 per cent. basis of excellence, the grade "excellent" is easier to reach in a small class than in a large one. If a class is divided arbitrarily into four groups, equal in number, as in the Missouri system, then the lower limit of merit for the top group is .6588 for a class of 100, .6268 for a class of 40, and .5972 for a class of 20. Twenty-five per cent. of a class of 51 members is 13, but only 12 of these have a mark above .6588 on the Pearson scale. Such variability of standards does violence to our sense of scientific rigor, though the practical results do not usually differ, owing to the fact that in practise only integral numbers apply.

In a scientific marking system the first requisite is uniformity of standards of reference. Lack of uniformity is sufficient reason for rejecting the classification into groups on the percentage basis, as in the Missouri system and others, unless that basis has some advantages which compensate for its theoretical defects. Such advantages it is difficult to discover.

To summarize, our proposed plan of marking is as follows:

1. A system of preliminary marking is used, merely to determine the rank of the students.

2. After the rank is fixed, each student is assigned the marks given in our table, with such slight modifications of the marks as are necessary in the judgment of the instructor.

The advantages of this system are:

1. It rests upon correct statistical theory.

2. The groups called "superior," "medium," "inferior" cover equal ranges of ability. These ranges are constant, no matter what the size of the class may be. Neither the top group, called "excellent," nor the bottom group, called "poor" has a fixed extreme limit, thereby providing, as the system should, for the grading of men of genius at one end and of the intellectual sluggards at the other.

3. It tends to eliminate the personal equation of the examiner.

4. The method is absolute, except in the determination of the deviations of the marks of a class from the *average* marks of classes of that size.

"This is a complicated system," you will say. So it is, though not quite so complex, perhaps, as it appears at first sight. Chemists and physicists know that any process of exact measurements requires time, patience and skill. That is true of our plan.

FLORIAN CAJORI

COLORADO COLLEGE,
COLORADO SPRINGS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION B—PHYSICS

SECTION B—Physics—of the American Association for the Advancement of Science held its meetings jointly with the American Physical Society during the convocation week beginning December 29, 1913, at the Georgia School of Technology.

Professor Anthony Zeleny, of the University of Minnesota, was elected vice-president of the section for the ensuing year. There were also elected to the Sectional Committee, Professor D. C. Miller, Case School of Applied Science, 4 years, and Professor G. W. Stewart, University of Iowa, 5 years.

As customary in the past all the shorter and more technical physical papers were given under the auspices of the American Physical Society. On the other hand the longer papers, and, in this case, those that dealt especially with geophysical problems, were grouped together and given under the auspices of Section B. These were:

The Methods of Physical Science, to What are They Applicable?: ARTHUR G. WEBSTER.

This was the vice-presidential address, and is given in full in SCIENCE, 39, pp. 42-51, 1914.

The Present Status of the Magnetic Survey of the Earth: L. A. BAUER.

A concise summary was given in this paper of some of the more important investigations undertaken, and conclusions reached, by the department of terrestrial magnetism of the Carnegie Institution of Washington. The great progress of the magnetic survey of the earth, as conducted by this institution, both over land and over water, was shown on a projected map. Many thousands of miles, even hundreds of thousands, have been traversed in obtaining the data necessary to the accurate magnetic mapping of the earth; nor were the routes followed along the safe and beaten tracks of travel, but rather across the least fre-

quented and even the more dangerous regions, and yet, in spite of the great distances travelled and all the excessive difficulties encountered, the entire survey has thus far been made without the occurrence of a single fatal accident.

Isostacy and the Size and Shape of the Earth: WILLIAM BOWIE.

The determination of the size and shape of the earth would be a simple matter if its geoid or sea-level surface formed a geometrical figure, but as it does not the actual problem is a difficult one. These deviations, it was shown, are due to differences in the vertical distribution of mass in adjacent isostatic regions. When corrections for the effects of topography and isostatic compensation are applied to the astronomically observed positions the deviation of the geoid from the spheroid surface is largely eliminated.

The shape but not the size of the earth may be determined from the observed values of the force of gravity at stations widely separated in latitude. Here again a correction for topography and isostatic compensation is necessary for the best results. Absolute values of gravity can be obtained only with a long series of observations, and therefore nearly all gravity determinations are made by the relative method. Those of the Coast and Geodetic Survey are based on the absolute value at Potsdam.

Investigations made by the U. S. Coast and Geodetic Survey during recent years show that the area of the United States, taken as a whole, is in a state of perfect isostacy, and that areas of limited extent deviate only slightly from that state. The paper will later appear in full.

Seismology: OTTO KLOTZ.

The most improved seismological apparatus, the data obtained by them and the conclusions logically deduced from this data were all discussed at some length. A full and interesting account, together with many illustrations, was given of a recent installation of seismological apparatus that registers in magnified form even those small vibrations of the earth's crust caused by the passage of ocean waves.

The Factors of Climatic Control: W. J. HUMPHREYS.

It was explained that such things as land elevation, oceanic circulation and volcanic dust in the high atmosphere are among the most important factors of climatic control, assuming of course approximate constancy of atmospheric composition and solar radiation.

Both the direct or primary and the indirect or secondary effects of each of these factors were explained in some detail and illustrated by statistical curves.

It is expected that the paper will later appear in full.

There was also one joint meeting with Section C—Chemistry, at which the following papers were presented:

Geochemical Research: JOHN JOHNSTON.

A general account of some of the main lines of geochemical work which are now being pursued in the geophysical laboratory of the Carnegie Institution.

The Ternary System Lime-Alumina-Silica: G. A. RANKIN.

The author discussed the results of an extended investigation of this system, which is important from a geological standpoint as well as from the fact that these three oxides are the essential ingredients in the manufacture of portland cement clinker. The fields of stability of all the substances which may be encountered in this system have now been determined satisfactorily; so that it is now possible to state precisely what happens when any mixture of the above three oxides is heated, and hence incidentally to specify the essential constituents of portland cement clinker.

W. J. HUMPHREYS,
Secretary of Section B

SOCIETIES AND ACADEMIES

ACADEMY OF SCIENCES OF ST. LOUIS

AT a meeting held June 1, Professor Nipher gave a brief account of a new method of decomposing water.

A continuous discharge from electrodes in separate beakers was made to pass through a capillary tube, forming a siphon connecting the water in the two beakers, water was decomposed at the electrodes and within the siphon. More than 50 times as much explosive gas was discharged from the siphon as was collected in the tubes around the electrodes. Distilled water which had been freshly boiled was used.

A full account of this result will be given in a volume now in the hands of the publisher, which will give a full account of the results of Professor Nipher's experimental work during the last five years.

C. H. DANFORTH,
Secretary

SCIENCE

FRIDAY, JUNE 19, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PROSPECT OF HUMAN PROGRESS[1]

MY principal purpose this evening is to invite you to look forward to the time to come and to enquire as to the prospect of human progress which is thus opened to view. But it will be necessary to give a great part of our attention to the past in order to build, as it were, a lookout from which we can obtain a vision of the future.

We shall not be so rash as to attempt a prediction of events or even of discoveries; but we shall try to determine the sort of progress which the indications of the present and the teachings of the past lead one naturally to expect. This will certainly be a safe procedure, provided that we can find common elements of fundamental importance in the basic characteristics of each period; for it can hardly be supposed that the future will suddenly depart from the principles of progress which have been impressed upon the race throughout its long period of evolution up to the present.

It will be necessary for us to pass in rapid review the great stages of development by which man has changed from a beast-like savage to a cultured civilian. We shall find that these stages have been marked off by a few leading inventions, each of them giving a fundamental new element to the period of progress following its appearance. In this review we shall be guided primarily by the researches and conclusions of ethnologists.

It is probably impossible to conceive of man existing as man and not having the elements at least of language for intercourse with his fellows. Therefore, by com-

[1] An address delivered to the Graduate Club of Indiana University on the evening of May 7, 1914.

mon consent, it has been supposed that primitive man was in the possession of spoken language, developed to such a degree as to enable him to communicate effectively with his associates.

A moment's reflection will be sufficient to bring to mind the immense importance of language to any animal fortunate enough to have found, by chance or otherwise, a means for its development. He has for the first time, in the words of his language, a sort of concrete receptacle for his thoughts. Prior to the acquisition of this tool for thinking, his thought had been, as it were, a fluid stream from which he could take up and hold permanently only that which would adhere to a sieve dipped into the stream. He could not give his thought objective existence as standing out before him. He could only feel its passage as it was driven through his mind by one impulse after another from his material environment. But with language at his disposal the case becomes different. Between the language and his thought there is a mutual reaction; and by means of the former the latter is deposited so that it may become the subject of objective study. The immense impetus which this would give to the development of the intellect must be apparent to every one.

There is another and greater element of development in the invention of language, namely, that which is associated with the power of intelligent intercourse. By its means our primitive man has become able to live in part outside of himself and in the thought of others. Thus he can project into himself the experiences of many other persons. This gives a new richness and a new meaning to his life. He is no longer confined to the range of his own experience as his means of development. All his contemporaries, so far as he knows them, can be made to contribute to his progress and be themselves gainers in the act. And even more than this is true: the experience of one generation can be passed down by tradition to the next. Thus the cumulative effect of the progress of one generation after another first became available to our primitive ancestors. It gave a great impetus to progress.

Indeed, it is true, I believe, that man has not yet taken another step of advancement of as great importance to him as this first one; and consequently I have dwelt on it at some length. It is also to be contrasted, as you will see, with the greater part of his later progress. For, it is essentially intellectual in its character, whereas much of the other depends for its value on the increased control which it gives man over his material environment.

The next stage of development was brought in, it is supposed, by the discovery of the uses of fire. The knowledge of fire is so widely distributed that it is a question whether any authentic instance is on record of a tribe altogether ignorant of it. By means of its use man became able to leave the tropical parts of the world and to go into the more invigorating temperate climates. He also had an enlarged and more nutritious food supply, owing to the increased value of many meats and vegetables on being cooked.

The next prime invention appears to have been that of the bow and arrow. Its chief contribution to progress is also in the increased and improved food supply which it made available. A tribe using the bow and arrow could have meats at all times. Such a diet probably contributed to increase the physical vigor and the courage of the savage possessed of it for the first time. The primitive tribes of Australia and Polynesia had not advanced to this stage when they were discovered a few generations ago.

It appears to be the general opinion that each of the three stages brought in by the three discoveries and inventions named endured for a long period of time, perhaps for something like one hundred thousand years or longer. In all of these stages our ancestors were yet in the savage state. The advance to the higher state of barbarism was brought about by the marvelous discovery of a means of making pottery. Man learned to fashion moist clay into a useful shape and burn it into hardness so that it would endure use. The vessels so constructed afforded him a means of boiling his meats and vegetables so that many of them became highly palatable, whereas they were almost or quite inedible when merely roasted before a fire.

Man, having advanced thus far, was still in a very unsatisfactory state when viewed from our present organization of communities with fixed abodes. He was necessarily nomadic. If he settled down to live permanently at a given place, then the animals, upon which he depended so largely for food would soon disappear from that vicinity both because he destroyed them and because he excited fear in them. But after a time he found means for overcoming this difficulty. Doubtless it had proved profitable, to both the men and the dogs, for the two to hunt together. Thus the dog came to be domesticated. When the idea that captive animals could be of service was clearly conceived, it was an easy step to the domestication of the sheep, the ox, the camel, the horse. Thus man came to have a meat and milk supply readily procurable at all seasons; in addition, he had in the horse and the dog valuable assistants in the chase. As his animals required pasture he came naturally to recognize the value of an increased yield from the soil. Thus, from being a herdsman, he gradually developed into a husbandman. Then he came to have fixed abodes, and the idea of nationality began to take definite shape.

At this stage of development man had no very effective tools. Wood and bone and chipped flints were the materials out of which were made such as he had. Presently some one made the master discovery of the art of smelting iron. From this time forward man was equipped with tools worthy his hand and his brain.

This invention brought in the last of the three periods of barbarism. Each probably extended over many thousands of years. During these periods man had leisure for the development of his artistic sense; and the way in which he used this leisure is indicated by the remains of his art which have endured to the present day—such as the wonderful paintings found in numerous caves in Europe.

The age of civilization, properly so called, was now brought in by an invention comparable to that in connection with which man emerged as man from his previous savage state. That early advancement, you will recall, was associated with the development of spoken language. The new age of civilization was brought in by the acquisition of written language.

From this time forward progress has been much more rapid than previously. The first stage of civilization extended over the period from the invention of writing to the close of the so-called middle ages, when a new stage was brought in by the invention almost simultaneously of gunpowder, the mariner's compass, paper and the printing press. Coupled with this was the scientific discovery and the demonstration by Copernicus that the sun and not the earth is the center of our planetary system.

These inventions and discoveries brought about simultaneously three fundamental revolutions in human thought and human

relations. By means of gunpowder the peasant became a match for the bravest knight, so that the latter could no longer trample over the former in safety. The castle of the lord no more could serve as a certain stronghold against danger. Gunpowder became a mighty leveling influence and began to prepare the way for equal rights to all men. Through the use of paper and the printing press books were soon widely distributed among a large class of people whereas before they had been the luxury of a few rich nobles. The advances in astronomy turned men's minds upside down, as it were, and set them to feeling that all conceptions of the world and of man were in need of fresh examination and possibly fundamental revision. Add to this the power of the mariner's compass, which enabled men to sail in safety across unknown seas, so that the whole wide world was about to come under their dominion. You can not fail to see that all these things, thrown as they were at once into experience, would undoubtedly produce a profound stir and commotion in the human mind. Such was the state of experience and such were the means of development in the middle stage of the higher civilization.

A period characterized by so much activity would naturally be one of rapid change. You would therefore expect it not to last long. Such indeed was the case. Only about four hundred years had elapsed when, towards the close of the eighteenth century, James Watt gave to the world the perfected steam engine. A new tool of power was thus in the hands of the men of that and future generations. It increased the working speed manyfold and thus brought in a period characterized by greater leisure for the cultivation of those elements of civilization not directly connected with obtaining a food supply. Man then entered upon the present stage of civilization, the highest to which he has yet attained.

We have now passed in rapid review the elements of the material basis for the progress of mankind. We have necessarily considered only the greatest outstanding facts. Now I should like to have each of you to take these facts and to build them into a lookout from which we may view for a few minutes the prospect of human progress. Or, if you prefer a different figure, will you consider these as constituting a mirror in time by means of which you can see in the past and the present the image of the future, just as by means of a mirror in space you see an extended image in one position while its object is in another.

In the first place, let us ask in what way these inventions and discoveries may be looked upon as the cause of progress. A cause may operate in two very different ways. If a ball is fired from a rifle the explosion of the powder *impels* it into motion and drives it forth. There are other causes in operation; but this is the fundamental impelling one. On the other hand, if the same ball is held at some height and the support is removed, it will also be set in motion. Undoubtedly the taking away of the support is one of the causes of its motion. It is not, however, the impelling cause; it is one acting by release.

If, now, we consider the means of progress we have mentioned, we can find no power in them through which they could have been the impelling causes of human progress. They undoubtedly operated by way of releasing the activity of man. We must assume, then, that there was a power of development inherent in human nature and that these inventions and discoveries merely released that power into activity. That appears to be the teaching of the whole of human progress. It is illustrated

also in the development of the individual. It is clear that the environment is not creating the growing intellect; but it is serving as a means of release to set free its activity and is thus making possible its attainment of power. The fire which lighted the savage's camp in the woods also kindled the intellect of the man who operated with it. It gave him new things to consider. Ultimately it put new tools into his hands and finally it has led his descendants into their most remarkable inventions.

These considerations make it clear that we shall have a fundamental understanding of progress only when we take into account the intellectual and moral and spiritual forces which are released or developed from age to age. These things are elusive; it is hard to get a grasp of them. They have in them the fluidity of life and they slip through our fingers so that we can hardly hold them. And yet they have doubtless had a profound influence of their kind, especially upon the relation of man to man. Consider, for example, this one command, "Thou shalt love thy neighbor as thyself." T. H. Green remarks that this has not varied in form during the whole of human development but that there has been a profound change in the answer to the question, Who is my neighbor? As our conception of duty and one's responsibility to his fellow has widened, we have given a broader and broader answer to this question, so that now every member of the human race is to be considered as our neighbor. Indeed, we have gone further than that and have come to include within the pale of our brothers even the most remote tribes of men. Obviously, this conception, moral or religious in character, must exercise a profound influence on the civilization of the future. Likewise other matters of this sort must have their important places; and we will give a just reflection of progress only when we take them into account.

In this connection I must call your attention more precisely to the interplay of material and intellectual forces. We have spoken of the former as releasing the latter. To stop here would be to give a very partial view of the situation. As soon as the intellect has come into play material things will be put into juxtaposition which are not found so in a state of nature. Thus the mind is able to release material forces which had not been in evidence before. These in their turn stimulate the intellect to a greater activity and thus increase its powers. Then we have new juxtapositions of natural things brought about through the deeper insight of the mind into the relations of phenomena. The connections which are thus put in evidence become more and more profound until at length we find man able to control the elusive electricity and by its means to transmit great powers of nature into his homes and his shops, subdued and taught to do his labor for him at his bidding. There seems to be no limit to the progress which may be engendered by this interaction between material and intellectual forces.

Of a similar character, but still more profound in its effect, is the quickening due to the intercourse of man with man. It was this, as we have seen, which characterized the first period of human development. One can not doubt that it has played a fundamental rôle throughout the whole range of progress.

It has been observed many times that a new vigor of character is produced by the intermingling of different races or nationalities of peoples at corresponding stages of development. The new is stronger than either of the elements which go into it.

There is a mutual stimulation which carries them into greater power than either could have attained alone. It is like the production of certain alloys where the mixed metal is much more useful than either of its constituents. The combination possesses properties which do not seem to be in either of the elements combined. It is this intermingling which gives to the character of colonial peoples that remarkable virility which it is often observed to possess. It is this which throws back from the colonies such an influx of power into the mother country. We shall get a picture of how all this is so if we consider the human race to have had at first certain potentialities of development and each group to have lost or to have weakened certain of these while developing others to a considerable or to a vast extent. What we get, then, by the intermingling of these different peoples is the reuniting of these various potentialities, in their developed and strengthened form, so that we come to have in a single individual a combination of elements of power which could be brought to him only by the junction of divergent streams of progress.

Looking at the matter thus we see strong grounds for optimism as to the prospect of further development. Never before in the history of the world has there been so much amalgamation of peoples as at the present time; and consequently there has never before been such an opportunity for reuniting the potentialities which have developed along divergent lines. There is greater facility of travel; means of communication have increased to a remarkable extent; and nations and peoples begin to exhibit a spirit of cosmopolitanism, so that the feeling of world citizenship is coming to play an effective part in the affairs of commerce and government. There is growing up also a demand for a universal language to facilitate intercourse; but what this will result in one can not at present predict with confidence.

World-wide intermingling of peoples carries with it, no doubt, its characteristic attendant dangers. The various local civilizations which were developed in earlier times, such, for instance, as those of Greece and Rome, ceased to flourish when their central populations became stagnant through the lack of accretions from without. It appears that one line of development can not continue indefinitely unless the potentialities which the people lose in their progress are supplied to them again by another people who have retained what the former had lost. Therefore, if the whole world should become a single community with a single life, we should have only one line of development in progress and hence should naturally suffer in the end a resulting stagnation.

This, however, is probably a danger which should not be anticipated. Though the whole world may be brought very close together by the present tendencies of civilization, it can hardly be supposed that it would grow into a single people with a single life. Such a thing has hardly yet taken place in England after a thousand years of close association on the part of peoples which were descended from a common stock not far removed. Furthermore, if any one should feel that there is ultimate cause for alarm in this matter, the problem could yet be safely left to the future for solution. We may be confident that it will be dealt with in a wise manner when it arises. So many new influences are now coming into play and so many lines of progress are converging into a great central stream that it would be hazardous to undertake a suggestion as to how this problem could be dealt with. It is a question for the future and the future must answer it.

Will you allow me, now, to turn abruptly

to an examination of these chief elements of progress from a different point of view, one which more precisely characterizes the outlook of the man of science? It is this latter point of view, I believe, which is most suggestive of the prospect of progress lying out before us.

If we look at those general elements which have characterized the principal stages of development—those, namely, of savagery, barbarism and civilization proper—we shall find that they are marked off by certain leading conquests, as follows:

During the period of savagery man was winning his way to a partial conquest of the world in the large. At its beginning he was confined to a relatively small portion of the earth's surface, namely, to the more tropical parts. This was true for two reasons: he had not yet discovered means to protect himself against the more rigorous climates; he also required to remain in a region where a food supply was available throughout the year. During the period, however, he acquired the control of fire and invented the bow and arrow. He thus became able to take care of himself throughout a much wider portion of the earth's surface, thanks to his increased control over material things.

In the next period, that of barbarism, he began to bring under his control the animal, vegetable and mineral kingdoms. The animals were taught to do his work and were kept also for a food supply. He learned to cook vegetables so as to render them much more palatable. Furthermore, he acquired the use of iron. In all this, you will observe, he was still dealing with things in the large.

During the next period, that of civilization proper, there was the first adumbration of a control of things in the small; but it was only an adumbration. It is the energy of molecules which gives to the steam engine its power; but this engine deals with them in the mass and not in the small. So has it been in the control of electricity attained during previous generations; men have not dealt with it in the small.

Thus, throughout all progress until the time of the last generation, it has been true that the conquests of men have been over things in the large.

There is strong reason to believe that we are now entering upon a new stage of progress brought on by the mastery of things in the small. I shall indicate briefly some of those over which we are now gaining such control.

We are no longer content to study electricity in the large; we have chased it down to the electron and probably even to the sub-electron. We are thus in a position to get a fresh insight into its phenomena. We have studied the various rays, visible and invisible, which are produced by the discharge of electric particles; and by means of them we have learned to photograph the bony framework and even the soft organs of the living human body. Here we have begun a conquest which we hope to carry on to many fundamental results.

Ordinary matter also is yielding up to us a more profound secret than we have ever before brought to light. This began with the study of emanations from radium and has been continued with a number of other substances. Furthermore, we have been able to strike off from atoms of various kinds the electron itself and have thus disclosed the intimate kinship of elements which previously had been considered entirely distinct. Here again we have just begun a conquest which we hope to carry on to many fundamental results.

Our men of science have also entered into the living organism and have begun to

study the basis of life itself. Witness the frequent investigation of living cells and even the elements, such as chromosomes, of which these are composed. Here the researches of Mendel and his followers come into play, revealing to us a new means through which we may hope ultimately to control even the character of those yet unborn. Here also we have just begun a conquest which we hope to carry on to many fundamental results.

There is one other mastery over things in the small to which I wish to call your attention, one having in it a great power for the development of strong and vigorous human beings, ready for the further advances of the future. I refer to our new and increasing knowledge of disease-producing germs. Here also we have just begun a conquest which we hope to carry on to many fundamental results.

Thus there has been opened to us in a short space of time a varied and undreamed-of world in the small over which we are now to gain the mastery. Our analysis of previous progress shows that we have here something vitally new. It should therefore lead to important development. Our confidence in this is great, since a little reflection on the matter brings out the fact that we now have converging into one main stream many of the elements which have characterized previous progress.

The actual development which we thus anticipate will be realized only if science indeed makes the conquests which seem to lie out before us. Why, then, may we feel sure of such advance? Time will allow only a brief answer. A slight examination of the past will put in evidence the fact that the fundamental discoveries of the earlier ages came about mostly by chance. Men were not seeking systematically to know the secrets of nature. They learned a few things in a haphazard way. They had not found out how to make a systematic and all-embracing search through fields either old or new. Fresh discoveries continue to be made right up to the present and with greater speed than ever before. New sorts of questions are asking for an answer. This indicates that the undiscovered regions yet to be found are vast in extent. To-day an increased number of persons are seeking the new. They have learned better methods of research and are able to go about their problem in a more systematic way. Undoubtedly there is still in human character the potentiality of great power to be released through the excitation of new discoveries. Therefore one can not fail to have the best of confidence that there is a long and important line of advancement now to be followed out.

Thus we have at hand every means of progress. The prospect is a pleasing one. He who works at this builds something into all subsequent human development. This is a labor worthy the mettle of the noblest intellect. The science of to-day is lighting the way of progress; and every real contribution to its results will make brighter the illumination of the future. I congratulate you that you have entered upon this labor. May the flower of science blossom at your touch and the vine of knowledge bear luscious fruit under your hand and the pure wine of its vintage flow forth to swell the stream of progress.

R. D. Carmichael

DEFINITENESS OF APPOINTMENT AND TENURE[1]

The college professor is rapidly being forced to occupy a new and important position in our public affairs and is receiving more of the

[1] Delivered before the College Section of the Association of American Agricultural Colleges and Experiment Stations, Washington, D. C., November 13, 1913.

recognition which his profession has long enjoyed in the older countries of Europe. A university professor who rose from the ranks occupies the White House; another is a prominent member of his cabinet; and large numbers of college and university professors are prominent in the direction of municipal, state and national affairs. This new appreciation of the teacher and the failure of some governing boards to understand their relation to him have led to a considerable discussion of his academic position from various points of view. Much of this discussion has centered around the matter of his tenure of office. Tenure is, of course, affected by the definiteness of the appointment, including its phraseology, and may be affected, though not necessarily so, by the method of appointment, which may vary widely without prejudice to the incumbent's tenure. Furthermore the method of retirement for old age by retiring allowances or pensions may have an important bearing, but need not be discussed after the very full presentation of this matter by Dean Davenport.

Although there has been considerable discussion of specific cases in which the matter of tenure has been involved, broad statements dealing with present customs and determining principles are few in number. The only satisfactory discussion I have found is that of President Van Hise[3] before the Twelfth Annual Conference of the Association of American Universities at the University of Virginia in 1910. In this address President Van Hise fully described the practise of the universities which are members of that association, and so clearly stated the principles which should govern that there seemed to be a general concurrence in his views. That association, however, includes only 22 of the leading American universities offering graduate work, 9 of which are not state-supported institutions, and only 7 are members of this body. It was evident, therefore, in order adequately to discuss this problem as it pertains to the land grant colleges, that facts must be secured concerning our present customs and the views of our members. Hence a questionnaire was sent to the presidents and deans of agriculture of all the land grant colleges. The replies received from forty-three institutions seem to justify the following statements.

Only eight institutions use definite forms for notices of appointment. Appointees are notified by the president in nineteen states, in ten by the secretary of the governing board, in two by both the president and secretary, and in one by the university treasurer. A formal acceptance is required at three institutions, sometimes only of instructors, and two use a written contract signed by the president and appointee. The time or conditions of tenure are specified in the appointment in nineteen institutions, and are not thus specified in ten. Duties are specified in the appointment in five institutions and merely by the title of the position in sixteen. In several colleges duties are thus stated if special reasons make it necessary.

The replies to the queries concerning the manner of appointment are neither conclusive nor illuminating, except in showing that there is no general usage and that it seems to be usually considered of but little importance. This is evidenced by the fact that in several institutions the appointee may be informed simply by word of mouth. Furthermore, some of the replies are evidently inaccurate, for some institutions state that they specify the time or conditions of tenure in their appointments which, as a matter of fact, do not do so. It is interesting to note that the few institutions which use formal appointments and are most definite in the form thereof are among those generally recognized as best administered and those which are most lax in this matter are among the smaller institutions. The most usual procedure is for the president to write the appointee that he has been elected to a certain position, naming the title and salary, and the date effective. It is usually stated

[3] Van Hise, C. R., "The Appointment and Tenure of University Professors," Journal of Proceedings and Addresses of the Twelfth Annual Conference of the Association of American Universities, pp. 50–61; also in SCIENCE, Vol. XXXIII., p. 237.

that the time of tenure and the duties involved are "understood" by both parties. The writer is convinced, however, that in most cases a definite statement of these matters is desirable in the appointment. A university president recently remarked that some one had said that all college presidents are liars. Obviously this exaggeration is due to the fact that no president, dean or director can remember all the "understandings" necessary to manage the affairs in his charge. The more business that can be done in writing the better, as is shown by the general practise of large business concerns. Doubtless railroad presidents would find it difficult to operate their roads and might also become eligible to the "Ananias Club" if they depended on "understandings" instead of written letters. In many cases this lack of definiteness in appointment is due to the fact that the institution has no generally established and generally understood policy concerning these matters, a situation which makes a system of definite appointment all the more necessary.

Furthermore, the appointment should state the principle and essential duties of the appointee. Usually the title of a full professorial position will be sufficiently indicative. If, however, an appointee is to be engaged in the college, station and extension work, or in more than one line, the appointment should clearly state the facts. Is it fair to appoint a man to an indefinite position and then expect him to do whatever sort of work he may be assigned, for some of which he may be poorly fitted, though otherwise well qualified? Should he be asked to change his line of work unless a new, definite and acceptable appointment is submitted to him? The by-laws of one institution states that "any teacher can be called upon for other duties without additional pay." Instances are not uncommon where dissatisfaction has arisen owing to assignment to work of a kind not contemplated by the appointment or previously "agreed upon." The replies to the questionnaire as to the appointment of professors for an indefinite or specific term were as follows. Twenty-two institutions appoint for an indefinite term; seven use a probationary period of one year and two or three years, followed by indefinite tenure; eight appoint annually, but claim the custom of reappointing during efficient service—a policy often expressed by formal resolution of the governing board so as to be equivalent to indefinite tenure; two appoint strictly annually, and one uses "either" method. In a few institutions professorial appointments are "permanent." If this phrase—permanent tenure—implies tenure for life or until old age retirement, it is much better than the term "indefinite," which really means nothing. Associate professors are usually given the same tenure as full professors, except in three institutions wherein appointments are made for definite terms of from one to five years. The institutions appointing annually, with a probationary term, and for indefinite tenure, do not form any natural grouping or classification. Only two of the ten making annual appointments are among our larger institutions and in these appointees undoubtedly enjoy indefinite tenure, though technically appointed annually. The nine institutions wherein probationary appointments obtain are widely scattered and are relatively small colleges. In practically all of the larger institutions professors enjoy indefinite or permanent tenure upon the first appointment.

In reply to the question whether all faculty members were appointed annually and whether such a system was opposed or favored, from the ten institutions wherein the system of annual appointments is in vogue only two writers favored the system, while three opposed it and five were silent. Thus there is practically unanimous opposition to annual appointments and commendation for the system of indefinite or permanent tenure, at least after a probationary period. The questionnaire elicited opinions to the effect that annual elections cause restlessness; deter strong men from accepting places subject to annual election; discourage loyalty to the institution; are commonly perfunctory; and create an uncertainty incidental to changes in the personnel of the governing board. One replies

that inasmuch as college salaries are relatively low owing to the assumed permanency of tenure, that it must therefore be guaranteed as a matter of justice. Another cites fifteen years of unsatisfactory experience with annual elections. Only two correspondents favor annual elections, one of whom says, "it works no disadvantage" and the other writes,

> I favor the system except as to the higher administrative officers for purposes of discipline and good service. I think the administrative officers should be allowed to feel secure in order that definite plans and purposes can be worked out.

There seems, however, to be nearly unanimous opposition to these views.

Several institutions observe annual elections, but practically guarantee indefinite tenure. Thus in Ohio the state constitution prevents any legislature from appropriating beyond its life and the university trustees hold that they can not legally contract beyond their appropriations. Hence appointments are made every year. However, the trustees have also passed a resolution stating that it is

> their desire that teachers should remain securely in their tenure of office and that the legal annual election was not to be interpreted as any uncertainty of mind on the part of the board of trustees.

Appointments are annual at Cornell University, but

> it is the established policy of the university that a man once installed continues indefinitely.

The notice of appointment also states that the salary is contingent upon the appropriations. It will hardly be questioned that at these two institutions professors enjoy permanent tenure, though technically elected annually. However, in some other institutions claiming to employ the same system, the situation is not as clear. One president writes:

> All the other members of the staff are technically reappointed for the year when the budget for the coming year is made out. Any one not reappointed at this time (June) is continued on the payroll until the first of September, giving him three months' notice. Usually when the employment of any one is to be discontinued we notify him sometime before June that if the budget is approved we will not recommend his reappointment.

One can not help but feel that where institutional traditions are not firmly established or where frequent changes may occur in the governing board, a system of annual elections must tend to militate against permanency of tenure and to make removal easier. Even the necessary annual budget may sometimes have a similar effect if the governing board does not clearly understand that its adoption involves merely a statement and not a reappointment. The inconsistency of the policy of some institutions was clearly indicated by one president who stated that his professors enjoyed indefinite tenure, but who held that to terminate a professor's service "he should not be reappointed and the reason should be given him." Boards have been known to secure removals by the simple process of dropping names from the budget.

It is difficult to see just what advantage accrues from or what necessity exists for annual elections. Were the position of the Ohio trustees tenable, most state institutions would be forced to elect annually, for both state and federal appropriations may legally be withdrawn at any time. Is not, however, a professorial position analogous to one held under the U. S. civil service? A civil service appointee enjoys an indefinite tenure during good behavior and is protected against removal except for good cause; but at any time Congress may fail to appropriate funds for a given salary or may abolish a position. Have not the trustees of state institutions the right to make permanent appointments, qualifying them with a statement that in so far as salaries are derived from appropriations they are dependent upon them? Would not such a system conduce to greater permanency of tenure?

Professorial appointments for trial terms of from one to three years followed by indefinite appointment is a different matter and may often be a desirable system. It is evident that our larger institutions can command the services of our best men and can so determine the worth of a prospective candidate as to

leave no doubt of his qualifications for permanent appointment. But at smaller institutions the full professor is often of the same grade as is the assistant or associate professor in the larger ones. It is not always possible to determine his worth or the wisdom of a permanent appointment until his ability is tested. Often young men are chosen who are expected to grow with the development of their departments. A trial alone will show whether they will or will not measure up to the expectations. Hence, a definite appointment for a probationary period, with the possibility of a subsequent permanent appointment is fair both to institution and appointee.

Information was sought by the questionnaire as to the tenure of assistant professors and instructors. Six institutions having indefinite tenure for professors appoint assistant professors for from one to five years and ten appoint instructors for a term of from one to three years. Only eleven institutions have indefinite tenure for all the faculty.

To the question whether short-term appointments for assistant professors and instructors were favored, twenty-two affirmative and fourteen negative replies were received. Most of our larger institutions have found such a procedure advantageous. Some of the comments on this matter are of interest. Dean Davenport, of Illinois, states that instructors being young men should move about from one institution to another, in order to gain experience and to work for advanced degrees; but that assistant professors only occasionally should be short term men, more particularly when they are first given responsibilities involving a good deal of trial. He remarks that sometimes when men are made assistant professors that they stop growing. President Hill, of Missouri, replies:

> It seems to me that the appointment for short terms is desirable until the efficiency and prospects for growth of an instructor or assistant professor are pretty clearly indicated. I take it, however, that there will always be some assistant professors in an institution who have already demonstrated their efficiency, but whom the administration is not yet ready to recognize as permanent members of the teaching force, preferring to see them first make good some of their promises in teaching and research.

These opinions seem fairly to voice the views of the majority, some of whom point out that short appointments of instructors encourage them to do graduate work.

It would seem that although a few institutions elect their professors annually, nearly all consider the term of the full professor as indefinite or permanent, at least after a probationary term. This being the case, the question of terminating the tenure of a professor arises. Three causes, viz., old age, gross misconduct or general inefficiency, may warrant his retirement. The matter of age retirement and the principles upon which it should be based depend largely upon the resources of the particular institution and need not be further discussed in view of Dean Davenport's masterly review of the subject immediately preceding the presentation of this paper. There would probably be no question as to the propriety of the removal of a faculty member for gross misconduct of such a nature as to make him an undesirable associate or teacher. Cases have occasionally arisen, however, where it has been claimed that men have been removed on account of their economic, philosophic or religious views, as expressed in their teachings. Probably injustice is sometimes done in this regard, but doubtless the aggrieved party has usually been removed more on account of his lack of a proper sense of propriety than because of his expressed doctrines. Undoubtedly we would all agree that absolute "academic freedom" must exist as far as the teaching of truth is concerned.

The really difficult cases are those in which the incumbent is generally inefficient or a misfit, in which it is unnecessary and undesirable to make detailed and definite charges, but in which there is no question that for the welfare of both the institution and the incumbent a severance of official relations is desirable.

With this situation in mind the questionnaire sought information by asking:

If a professor is appointed with an indefinite tenure of office, what should be the method of terminating his position if his services are unsatisfactory, provided there are no specific charges against him?

Nearly all who replied to this question indicated that the president should hold a frank conference with the man and urge him to relocate, and should give him ample time wherein to secure a new position. Replying to the query as to what constitutes such ample time, three favored two months, five three months, two four months, fourteen six months and five a year. Two of our most experienced executives stated that they had found a year too long a period, as it interfered with the work of their institution. Dean Davenport has answered these questions so well that I again quote from his letter:

This is an exceedingly delicate question. It refers, of course, to that kind of lack of success which it is difficult to define and certainly against which specific charges can not be made. Personally I believe if the case is not flagrant and the institution is large enough and strong enough to do it, it is best to supersede the position in some quiet way and by reorganization to push the work ahead without the man. But if the issue must be met squarely, then I believe in doing it by the frankest method possible; namely, by discussing the matter with him and showing him why it is that the university must have a change. I think that in the case of a man's becoming undesirable in a responsible position, the very fact that he has been given this responsible position entitles him to great consideration. It seems to me that the best plan is for the institution and the man alike to understand the situation and both to do what they can to find another position where the man can presumably succeed. I do not mean by this that an incompetent professor should be peddled off on another institution; only this, that if the institution ever gave him a professorship, it must have been for a very good reason and his failure is most likely to be due to changing conditions. Under such considerations it is not difficult to find other places where the conditions are more favorable for good work. Except in rare cases, therefore, I would not make the notice definite, but rather indefinite.

Occasionally a case arises in which such treatment must be followed by definite action. Sometimes a man refuses to make a reasonable effort to secure another position, even after he has been given ample time to do so. Under such circumstances we doubtless would all agree that it would become necessary to formally request his resignation.

In reply to the query whether under such circumstances the notice should be made a matter of record where it may become public, only four answered "yes," and all other replies were "no." There seems no good reason why such a matter should be recorded as public property unless the man himself makes such action necessary. This simply means that in most institutions such notice should be given by letter from the president and not by action of the governing board, which usually becomes public.

The final question asked whether there is any justification for a new managing board declaring all positions vacant and reappointing whomsoever they see fit. Only two replies indicated that possibly circumstances might arise warranting such action. The other forty replies are so emphatic in their condemnation of such a proceeding that the query might seem useless. However, according to published reports there have been one or two recent cases of such drastic action. Formerly such "turnovers" were much more common. Some of these replies may well be quoted if for no other purpose than to voice the universal sentiment of all college men. One writes:

It is a cowardly way to treat the situation.

President Snyder of Michigan writes:

A new managing board that declares all positions vacant is simply advertising to the world its own inefficiency and lack of appreciation of the great responsibility which has been placed upon it.

President Aley of Maine writes:

I know of no justification whatever for a new board to declare all positions vacant. It seems to me that such a proceeding will result in chaos in an institution. Certainly no self-respecting man would want a position in a college where such a thing is likely to occur.

President A. R. Hill of Missouri expresses himself as follows:

I can see no justification for a new managing board declaring all positions vacant and reappointing whomsoever they see fit. The appointment by any managing board I regard as a mere formality. The real appointment should always be made by the faculty of the department concerned, including, of course, the president and dean who are members of that faculty, meaning by department, as a rule, what used to be meant by chair. Where the faculty of a school or college is small, as in the case of most law schools, the entire faculty of the school should be consulted. I do not mean that a formal vote of the faculty of the school or department need be taken either in making the appointment or in severing the relationship; but the actual sentiment of the faculty should be voiced in either action and when this is the case the action of the Board who are not educational experts, should be merely formal.

Mr. V. H. Henderson, secretary of the regents of the University of California, says:

For a new managing board to declare all positions vacant and to reappoint whom they see fit, is apt to prove a mistake. A wholesale violence of this sort has been proved by the history of American university life ordinarily to result in weakening an institution and hindering its healthy and normal development. As a matter of university planning it is very much better if a managing board shall not itself be a "new board"—that is to say, the governing board should be made up of a body of men whose terms expire at different times, so that the board shall always contain a considerable proportion of members who are thoroughly acquainted with the work of the institution and sympathetic with the purposes and ideals of American university work.

Mr. Henderson then makes the same point as does President Hill:

In the University of California, all initiative as to appointments, promotions, salaries and changes of title is with the president of the university. He invariably obtains the approval of the finance committee of the regents to the creation of a new position, or to changes which involve increase of expenditure, but the initiative in these matters remains with him and questions of personality remain with him. That this should be the case is an essential for the best success of any educational institution, whether it be a university or a city school system.

Mr. Henderson strikes at the basis of much of the trouble in regard to tenure. Where governing boards consider it their duty to take the initiative in the appointment or retirement of members of the faculty without the approval of the president, trouble is certain to ensue. With the formation of single boards governing all a state's educational institutions, a system now being tried in several states, this policy becomes all the more necessary, for it will be entirely impossible for members of such boards to have much personal knowledge of the fitness of the candidates.

I have endeavored to present to you the prevailing custom upon these matters in the land-grant colleges. Evidently, there is a considerable divergence of policy among the several institutions, the smaller of which may sometimes need to pursue a somewhat different course from that found satisfactory to those enjoying larger resources. However, it would seem fairly evident that there are certain general principles concerning the matter of definiteness of appointments and tenure which should be observed by all. If these could be clearly formulated by our committee on college organization and policy, and then be adopted by this section, would not such action be of considerable value in encouraging a more uniform practise and be a most welcome support to many of our college executives?

E. D. Sanderson

College of Agriculture,
West Virginia University

THE PORTO RICO SURVEY

The New York Academy of Sciences has begun a scientific study of the island of Porto Rico along the lines of geology, paleontology, zoology, botany, anthropology and oceanography. With the assistance of a friend, the academy has voted to expend \$1,500 a year for five years on this work, and cooperation with the academy has been assured by the American Museum of Natural History, the New York Botanical Garden and by scientific depart-

ments of Columbia University, New York University and other institutions. Furthermore, on account of the representations made by the academy through its representatives, Professors Henry E. Crampton and N. L. Britton, the insular government of Porto Rico has made an appropriation of $5,000 toward the work for the fiscal year beginning July 1, 1914, with the expectation that this appropriation would be repeated on each ensuing four years.

The committee having the work in charge consists of Professors N. L. Britton, James F. Kemp, Franz Boas, C. L. Poor and H. E. Crampton. In furtherance of the project, Professor Crampton visited Porto Rico in December and January and Professor Britton and Dr. Lutz in January and February last, and the work is now well under way. Some of the aspects of the work are as follows:

GEOLOGY

Not much is known in detail about either the geology or the paleontology of Porto Rico, so that the field is very attractive. Much, too, remains to be done on the economic geology of the island. The geological portion of the scientific study of Porto Rico will be begun this summer by Professor Charles P. Berkey, who expects to sail for Porto Rico about the middle of August and to spend a month in reconnaissance work on the island. He will probably be accompanied by some other member of the New York Academy of Sciences. Dr. Berkey plans to cross and recross the island at as many points as are available in the time; to gain a general idea of the run of the formations and collect as many specimens as possible. Next winter and in subsequent seasons the details of particular sections will be elaborated by other workers, and the mineral resources will be specially studied. Attention will also be directed with great care to the fossiliferous strata.

ZOOLOGY

In the department of zoology, the field is wide and varied, and the organisms to be investigated are especially numerous. The work was begun in January, when Professor Crampton completed a reconnaissance of the island in order to map out the different ecological regions for further intensive study. Dr. Frank E. Lutz was a member of Professor Britton's party which investigated the islands of Desecheo and Mona, as well as certain areas of the main island. His collections comprise 10,000 insects, and notable series of land molluscs and other forms.

During the coming summer Mr. Roy W. Miner will begin the detailed investigation of the invertebrates of the shores and estuaries, especially those of the harbors of San Juan, Ponce, Mayaguez and Vieques. The coral reefs off the southern and western shores will also receive attention. Mr. John T. Nichols begins the collection and study of the fishes of the same regions, working with Mr. Miner so as to correlate the studies in these two fields.

For the study of the rich division of entomology, three investigators will take the field. Mr. H. G. Barber and Mr. F. B. Watson leave New York on July 4, and Mr. Charles W. Leng will go to Porto Rico later in the summer. They will study intensively certain characteristic regions mapped out by Professor Crampton and Dr. Lutz. The entomologists of government institutions are cooperating with the survey in this department of activity.

BOTANY

The botany of Porto Rico is fairly well known along several lines, but much field work is still desirable for satisfactory knowledge of the fungi and the lichens, and additions to the known flora in other groups can doubtless be made by further exploration of regions of difficult accessibility. The reforestation of portions of the island is one of the most important economic problems of the colony. Several of the members of the scientific staff of the New York Botanical Garden have given much time to Porto Rico, and the results of their labors will be used in further research there by them. Dr. Britton visited the island in January and is going there again in August.

ANTHROPOLOGY

The anthropology of Porto Rico offers an attractive field of study not only in the ethnology of the present inhabitants, but also and more particularly along the lines of archeology. Much material has been gathered from the surface, but a broad field is offered in the investigation of anciently inhabited caves and in the scientific working over of numerous kitchen middens.

OCEANOGRAPHY

The oceanographic work falls naturally into two general divisions—physical and biological. In both of these divisions there is opportunity for new and very valuable research.

The physical division should include a study of the tides and of the ocean currents in the neighborhood of Porto Rico. The present tidal data consist of several short and disconnected series of observations—the longest series having been made at San Juan in 1899. Observations of ocean currents are few and crude—those of the *Blake* were obtained by comparing dead-reckoning positions of the vessel with observed positions.

Tidal observations could best be carried on by the establishment of self-registering gauges. These could be established at the principal harbors and continuous records for several months or a year obtained.

Current observations to be of value must be obtained by a properly equipped ocean-going vessel, and such a vessel could obtain in a short voyage results of extreme value. At the same time, the vessel could and should be equipped for biological study—the current observations and the deep sea dredging for animal life going on side by side. For these two branches of oceanographic work a vessel is absolutely essential.

The specimens which are collected will eventually find lodgment in the American Museum of Natural History, except for the "first set" of duplicates. These will be deposited with the authorities of Porto Rico for the inauguration of an insular museum, and the academy's investigators will take particular pains to insure the good quality and extent of this series.

EDMUND OTIS HOVEY

THE NINTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

PROFESSOR PAUL WELDEN, president of the congress, in a personal letter writes as follows:

1. The meetings will be held in St. Petersburg from the 8th to the 14th of August, 1915.

2. Excursions are to be made to Finland, Moscow, Kiew, Baku in the Caucasus, etc.

3. In addition to the usual addresses, systematic reviews of the work in particular fields (with discussions) are to be given by specialists, on the invitation of the committee of organization, to a greater extent than formerly.

4. Particulars as to receptions, entertainments, etc., can only be given later.

5. The question of reduced railway fares on the Russian railroads is now under consideration by the government.

6. No obstacles will be placed in the way of the journey of Jewish chemists to the Congress provided (*a*) that at the frontier, in addition to the vised passport (requisite for every passenger), cards of membership, signed by the president and honorary secretary of the congress shall be presented.

7. An announcement of the Ninth International Congress in English will be sent in the course of the next few days or weeks to North America and England.

THE RUSSELL SAGE INSTITUTE OF PATHOLOGY

AT a meeting of the board of directors of the Russell Sage Institute of Pathology, held in New York on June 5, the following officers were elected:

President, Dr. D. Bryson Delaven.
Vice-president, Dr. Simon Flexner.
Secretary, Dr. Theodore C. Janeway.
Treasurer, Dr. Graham Lusk.

Appointments to the scientific staff were as follows:

Scientific director, Dr. Graham Lusk.
Medical director, Dr. Eugene F. Du Bois.
Chemist, F. C. Gephart, Ph.D.
Assistant, Dr. A. L. Meyer.

Dr. Lusk reported for Dr. Du Bois that 142 observations had been made upon patients and on some normal controls during the past year and a half, using the respiration calorimeter established in the second medical division of Bellevue Hospital. In certain individuals an exact agreement between the actual heat production and the heat calculated from the gaseous exchange during hourly periods, was obtained for the first time in man. In the total of all experiments involving the measurement of 23,000 calories, these two methods of direct and indirect calorimetry agree both in health and disease within 1¼ per cent. The investigated cases included nine cases of typhoid during both fever and convalescence, one cretin, seven cases of exophthalmic goiter, one of splenic anemia, another with pernicious anemia, one man with acromegaly, one with hypopituitarism, one with malaria, and one with auricular fibrillation, mitral stenosis and greatly enlarged heart.

SCIENTIFIC NOTES AND NEWS

DR. ROBERT S. WOODWARD, president of the Carnegie Institution of Washington, will give the address on the occasion of the dedication on July 10 of the new laboratory building of the Marine Biological Laboratory at Woods Hole.

THE Croonian lecture of the Royal Society was delivered on June 11, by Professor E. B. Wilson, of Columbia University, on the bearing of cytological research on heredity.

THE Franklin Institute of Philadelphia has awarded its Edward Longstreet medal of merit to Dr. W. J. Humphreys for his paper on "Volcanic Dust and Other Factors in the Production of Climatic Changes and their Possible Relation to Ice Ages," which appeared in the August, 1913, issue of its journal.

THE triennial Parkin prize of $500 of the Royal College of Physicians of Edinburgh, has been awarded to Dr. Johnson-Lavis for his work on the effects of volcanic action in the production of epidemic diseases in the animal and in vegetable creation, and in the production of hurricanes and abnormal atmospherical vicissitudes.

THE University of Manchester proposes to confer the following honorary doctorates of science: Professor W. H. Bragg, University of Leeds; Professor W. J. Pope, University of Cambridge, and Dr. J. E. Stead, Middlesbro'.

PROFESSOR R. G. D. RICHARDSON, of the department of mathematics at Brown University, has been elected to membership in the American Society of Arts and Sciences.

PROFESSOR R. C. ARCHIBALD, of Brown University, has been made a member of the editorial board of the *Bulletin* of the American Mathematical Society. Professor Archibald has also had a book by him on "The Lost Book of Euclid" accepted for publication by the Cambridge University Press.

THE Royal Society of Edinburgh has awarded the Neill prize to Dr. W. S. Bruce, in recognition of the scientific results of his Arctic and Antarctic explorations, and the Keith prize to Mr. J. Russell, for his investigations relating to magnetic phenomena in metals and the molecular theory of magnetism.

PROFESSOR A. W. GOODSPEED, director of the Randal Morgan Laboratory of Physics, University of Pennsylvania, has been granted leave of absence for the session of 1914–15. He leaves with his family for Germany on June 25.

PROFESSOR METCHNIKOFF, of the Pasteur Institute, is to be presented with a memorial volume to celebrate his scientific jubilee and his seventieth birthday.

DR. J. J. STEVENSON, emeritus professor of New York University, was entertained on May 28 at a dinner at Pottsville, Pa., by Mr. Baird Halberstadt. There were present a large number of those engaged in the mining industry, to which Professor Stevenson's researches have so greatly contributed. Among those who spoke were Dr. I. C. White, of the University of West Virginia, and representatives of the

Pennsylvania Geological Survey and of the coal industry.

At the meeting of the Cambridge Philosophical Society held on May 18, as we learn from *Nature*, the following were elected honorary members of the society: Dr. H. E. Armstrong; Professor J. Bordet, the University, Brussels; Madame Curie, the Sorbonne, Paris; Professor F. Czapek, the German University, Prague; Professor T. W. Edgeworth David, the University, Sydney; Colonel W. C. Gorgas, Medical Corps, U. S. A. Army; Professor P. H. von Groth, the University, Munich; Professor Jacques Hadamard, the Collège de France, Paris; Dr. G. E. Hale, director of the Mount Wilson Solar Observatory; Dr. François A. A. Lacroix, Natural History Museum, Paris; Professor C. Lapworth, late professor of geology, the University, Birmingham; Professor H. Lebesgue, the Sorbonne, Paris; Dr. Jacques Loeb, the Rockefeller Institute, New York; Professor Arthur Looss, the Government School of Medicine, Cairo; Professor H. A. Lorentz, the University, Leyden; Professor M. Planck, the University, Berlin; Lieut.-Col. Leonard Rogers, the Medical College, Calcutta; Professor Gustav Schwalbe, the University, Strassburg; Dr. Karl Schwarzschild, the University, Berlin; Dr. D. H. Scott, foreign secretary, Royal Society; Professor E. B. Wilson, Columbia University, New York; A. F. Yarrow, Blanefield, Glasgow; Professor P. Zeeman, the University, Amsterdam. The society will celebrate in 1919 the centenary of its foundation.

Dr. W. H. R. Rivers has been appointed to represent the University of Cambridge at the nineteenth International Congress of Americanists to be held at Washington in October next.

The Hon. Bertrand A. W. Russell, lecturer in Trinity College, Cambridge, has been elected Herbert Spencer Lecturer for the year 1914–15 at Oxford.

Sir Joseph Wilson Swan, known for his important discoveries in connection with the carbon filament lamp, electro-chemistry and photography, died on May 27, in his eighty-sixth year.

Dr. Philip Henry Pye-Smith, a distinguished London physician and man of science, died on May 23, at the age of seventy-five years.

The death is also announced of Dr. George Dean, regius professor of pathology in the University of Aberdeen.

The U. S. Civil Service Commission announces an examination for an assistant physicist, qualified in metallography, to fill a vacancy in this position in the bureau of standards, Department of Commerce, Washington, D. C., at a salary of $1,400 to $1,800 a year.

The magnetic survey yacht *Carnegie* left Brooklyn, on June 8, under the command of Capt. J. L. Ault, for a cruise in the North Atlantic Ocean to Norway (Hammerfest) and Iceland. The vessel will return to Brooklyn again about December 1.

The schooner *George B. Cluett*, of the Grenfell Association, has been chartered by the department of terrestrial magnetism of the Carnegie Institution of Washington for a cruise to Hudson Bay this summer. The expedition will be in charge of W. J. Peters, assisted by D. W. Berky, and will leave Battle Harbor, Labrador, on July 1.

Owing to the fact that the Cartier celebration will be held in Montreal during the week beginning on September 6, and the resultant congestion of hotel and transportation facilities, the meeting of the American Chemical Society in that city has been changed to September 15–18.

The seventh congress of the International Association for Testing Materials will be held under the patronage of the Czar of Russia, in St. Petersburg, on August 12–17, 1915. After the congress extensive excursions in the interior of Russia have been arranged.

By the will of Harris Charles Fahnestock, of New York, $550,000 is bequeathed to New York city hospitals and charities.

THE Council of Mathematical Teachers in New England has recently appointed a special committee on the status and welfare of mathematics in secondary schools, to investigate and report on current criticisms of high school mathematics. The membership of the committee is as follows: Mr. G. W. Evans, Charlestown High School; Professor F. C. Ferry, Williams College; Mr. A. V. Galbraith, Middlesex School; Mr. F. P. Morse, Revere High School; Mr. C. D. Meserve, Newton High School; Professor S. E. Smith, Mount Holyoke College; Miss H. R. Pierce, Worcester High School, and Professor H. W. Tyler, Massachusetts Institute of Technology, *chairman*. Correspondence with persons having special information is invited.

A CONVENTION of Tau Beta Pi, the honorary engineering society, will be held in Ithaca on June 11, 12 and 13. One delegate from each of the twenty-seven chapters and the five alumni chapters will attend. The general program includes business meetings on each of the three days and numerous excursions and social meetings.

As we have already announced there will be held a celebration on July 24 to 27 under the auspices of the Royal Society of Edinburgh, of the tercentenary of the publication of Napier's "Mirifici Logarithmorum Canonis Descriptio," the work which embodies the discovery of logarithms. Lord Moulton will deliver the presidential address on July 24; and many distinguished mathematicians, astronomers, actuaries and engineers will make communications on July 25 and 27. An exhibition of calculating machines, apparatus and books, and of objects associated with Napier and the history of mathematics, will be held in connection with the celebration. Immediately following a mathematical colloquium will be held on July 28 to 31, under the auspices of the Edinburgh Mathematical Society. The following courses have been arranged for in connection with the colloquium: Two lectures on Nomography, by M. d'Ocagne, professeur à l'Ecole Polytechnique, Paris; four lectures on Infinity in Geometry, by H. W. Richmond, King's College, Cambridge; four lectures on Critical Studies of Modern Electric Theories, by E. Cunningham, St. John's College, Cambridge; two lectures on The Solution of Algebraic and Transcendental Equation in the Mathematical Laboratory, by E. T. Whittaker, professor of mathematics in the University of Edinburgh.

UNIVERSITY AND EDUCATIONAL NEWS

AFTER several months' investigation the plan of the presidential commission for national vocational education has been presented in the senate in a bill introduced by Senator Hoke Smith, one of the commissioners. It proposes an expenditure by the federal government of $1,500,000 next year for the salaries of teachers of agriculture, trade, industrial and home economics. The amount would increase automatically each year until 1924, when the total would reach $7,000,000. An equal amount must be expended by states. A federal board of vocational education would consist of the postmaster general and the secretaries of interior, agriculture, commerce and labor. State boards of not less than three members each would be provided.

THE Sheffield Scientific School, Yale University, has received a provisional gift from a graduate of $100,000. This gift is contingent upon the securing of an additional $100,000; the money to be used for the development of a graduate course of one year, and, if possible, two years, as an addition to the present undergraduate course known as the select course, in preparation for business and business administration.

AT the annual commencement of Gustavus Adolphus College, St. Peter, Minnesota, announcement was made of the completion of an endowment fund of $250,000. The two largest contributors were James J. Hill, of St. Paul, and C. A. Smith, of Minneapolis, each of whom gave $50,000. On the same occasion Oscar J. Johnson was formally inducted into office as president of the institution.

It is announced that the Carnegie Foundation for the Advancement of Teaching has undertaken to grant pension allowances to the director and faculty of the Carnegie Institute of Technology and also to the directors of the Carnegie Museum and the Carnegie Department of Fine Arts, and such of their curators as do teaching work, under the rules and regulations of the foundation.

The School of Physiology, presented to the University of Cambridge by the Drapers' Company was opened by Prince Arthur of Connaught on June 9. The cost of the building, with the contribution made by the company towards its equipment, has amounted to £23,500.

On June 3 the University of Missouri celebrated the seventy-fifth anniversary of its founding. Addresses were delivered on this occasion by former Governor David Rowland Francis, president of the board of curators, Albert Ross Hill, president of the university, the Hon. William Rock Painter, lieutenant governor of Missouri, the Hon. William Prentiss Evans, state superintendent of public schools, Frederick Aldin Hall, acting chancellor of Washington University, David Francis Houston, secretary of agriculture, Harry Burns Hutchins, president of the University of Michigan, and Cassius Jackson Keyser, professor of mathematics in Columbia University. On the following day, President Lowell, of Harvard University, delivered the commencement address, and the degree of doctor of laws was conferred on President Lowell, Secretary Houston, Professor Keyser and Mr. William Mack.

Dr. Arthur Kenyon Rogers, professor of philosophy at the University of Missouri, has been called to Yale University to succeed Professor William E. Hocking, who goes to Harvard University.

Assistant Professor William D. Harkins, of the department of chemistry at the University of Chicago, has been promoted to an associate professorship in chemistry.

Dr. C. H. Shattuck, head of the department of forestry at the University of Idaho, was recently elected dean of the college of letters and sciences of that institution.

Miss Jessie Y. Caun, Ph.D. (Columbia), head of the department of chemistry, Rockford College, Rockford, Ill., has accepted an instructorship in chemistry at the University of Illinois.

DISCUSSION AND CORRESPONDENCE

SOVEREIGNS AND THE SUPPOSED INFLUENCE OF OPPORTUNITY

A serious criticism has been made of my theory that the high intellectual qualities found in royal families are the results of natural and sexual selection and inherent in differences in the germ-plasm. My belief is that differences of opportunity may have played some rôle, but my contention is that all the evidence we possess points in the opposite direction, and the conclusion is that differences in opportunity have been on the whole of comparatively trivial importance.

One of the eight reasons in support of this theory, which I have given in "The Influence of Monarchs" (New York, 1913), page 258, is that "younger sons of kings are not less eminent than heirs to the throne." By eminent I mean of high intellectual grade. For this statement I drew upon statistics published in "Heredity in Royalty" (New York, 1906), page 285, and again here presented in Table I. below.

TABLE I

Grades	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Total
Total number in each grade	7	21	41	49	71	70	68	48	18	7	395
Succession inheritors	5	14	26	31	49	38	45	28	12	4	247
Per cent.	71	67	63	64	69	54	67	54	67	57	62.5

These 395 persons were the 395 adult males 25 years or over who were graded for intellect in "Heredity in Royalty," pages 20–26. About three fourths of these individuals belong as descendants in the direct male lines of families studied. The other quarter enter the lists as ancestors, usually direct ancestors, in the various maternal lines. As far as one

can see from this table there is no tendency for the mentally superior grades (8), (9), (10) to be filled with succession inheritors.

It is thus seen that from 54 to 71 per cent. inherited the succession in the different grades. The upper grades are in no way composed of men whose opportunities were enhanced by virtue of this high position. Thus we see that a certain very decided difference in outward circumstances—namely, the right of succession—can be proved to have no effect on intellectual distinction, or at least so small as to be unmeasurable without much greater data.

The criticism which I have received comes in the form of a private letter from Professor J. McKeen Cattell and is so much to the point that it has called for the reinvestigation which I am here giving. The criticism is as follows:

It seems to me that the figures in your table ("Royalty," p. 285) may be explained by the fact that the monarchs attaining (9) and (10) come from a smaller group than those who are not monarchs. The encyclopedias would note all those attaining ranks (9) or (10) whether monarchs or not. The heredity being the same, the non-monarchs should, on your hypothesis, supply a larger number in these grades. As the monarchs supply one half of the (9) and (10) grades (there appears to be an error in the percentage under (9)[1]) it follows that their grade was increased by their office. In grades (1) and (2), on the other hand, monarchs would be more likely to be included than other members of royal families.

It will be at once seen that this criticism is directed towards two points which I had not at that time determined—(1) what are the chances that an adult male member of the families studied will succeed to the throne. In other words, what is the per cent. of sovereigns to non-sovereigns when all adult males are considered? (2) What allowance should be made for the "obscure" princes or sovereigns? How many of these are there and is their presence such as to introduce a significant error?

It is not surprising that one unacquainted with royal genealogies should suppose that the total number of reigning sovereigns should be less than the total number of younger brothers (non-inheritors of the succession). The House of Hanover in modern England would give one this false impression. Here 20 adult males furnish but 6 reigning sovereigns. But the precise record of all the direct lines included in my study shows that this is a marked exception. On the average a little more than half of the males (who live to be 25 years) have become reigning sovereigns by inheritance. This is due to the fact that, in spite of the high fecundity in royal families. during the period studied, the adult males average only between 2 and 3 (2.33 in Table II.) in each "fraternity." There are many instances where a sovereign succeeds his brother, and this brings the proportion to more than one in two.

The percentage 62.5 for succession inheritors, in the table given above, is somewhat higher than that given for the table below perhaps in part because the table above included maternal grandfathers. These are sometimes of houses of less importance and grandeur than the great houses that form the chief male lines. It is probable that they are not often younger sons, consequently they are more apt to be sovereigns. Be that as it may it makes no difference since an accurate and systematic table is now prepared. These figures which are given below (Table II.) deal with the 832 adult persons who are in the male lines in "Heredity in Royalty." 403 of these are males. 220 or 54.6 per cent. became sovereigns by inheritance. The genealogy which I have used is the exhaustive and authoritative "Genealogie der in Europa regierenden Fürstenhäuser" by Dr. Kamill von Behr. It contains the direct lines of all the "Reigning Sovereigns" families of the present day. These are the same as found in the "Almanach de Gotha," Première Partie, but the "Genealogie" of von Behr traces them back as far into the past as possible. Von Behr does not include the non-reigning families, found in the "Almanach de Gotha," Deuxième Partie. These mediatized German royal families have the rights of equality of

[1] This is a typographical error. The 8 should read 12.

birth with the reigning sovereign houses, but have not reigned since the Napoleonic era. It is easy to tell the actual sovereigns in von Behr as they are printed in capital letters. These are not always kings; a few are of ducal and princely royal houses, but even here some inherit the succession as sovereigns while others do not. With the exception of Montmorency (6 members) all the persons in the following tables are of strictly royal families.

Of the 403 persons in Table II., 94 are "obscure"; that is, not enough could be easily found out about them to warrant grading them for intellect in a scale of 10. More careful researches than I have yet been able to make, would doubtless reduce the number

TABLE II

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	r
Sovereigns by inheritance	5	9	24	23	44	30	39	16	7	4	201
Non-sovereigns	1	9	9	12	18	22	16	12	6	3	108
Probable distribution of "obscure" sovereigns			1	7	10	1					19
Probable distribution of "obscure" non-sovereigns	1	2	11	20	32	7	2				75
Corrected sovereigns	5	9	25	30	54	31	39	16	7	4	220
Corrected non-sovereigns	2	11	20	32	50	29	18	12	6	3	183
Per cent. of sovereigns	71	45	56	48	52	51	68	57	54	57	54.6

of the "obscure," but I have always felt that this was not necessary to secure the conclusions which have been obtained. It is not necessary to secure the heredity correlations, and now it appears that the error which this introduces is not significant for the present inquiry. Of these 94 obscure members, 19 are sovereigns and 75 are non-sovereigns. The sovereigns are almost certainly and non-sovereigns probably, not worthy of grades (8), (9) or (10). They would probably form a curve of distribution about the grades (4) and (5). The non-sovereigns would find their center a little higher and spread out a little more. They are approximately arranged in the third and fourth horizontal columns.

Now it can be seen that grades (3), (4), (5) and (6) as they appear in the uncorrected horizontal columns, at the top of Table II., will stand the introduction of a number of non-sovereigns without dimising the 54.6 per cent. which is the average. Can these 94 "obscure" members be placed in Table II. without overbalancing the results? The reader will see that they can. For although the 75 "obscure" non-sovereigns count against my thesis, the 19 "obscure" sovereigns count in its favor; and all added together give a confirmatory result. In the previous investigation there were about 62 per cent. in each grade, who were sovereigns; now there are about 54. The truth of the whole matter is, that while there are, in the second research, a large number of (4) and (5) grades among the sons, in the previous research these mediocre persons were represented in the ancestry. The previous statistics could not settle the question of how many there were who were "obscure." The present research does settle the point, since it takes them up one by one and counts them all, in a series of "fraternities" one generation after the other.

Those who look carefully will see that there is a slight tendency for the sovereigns to run to the higher grades, but such a tendency is negligible for two reasons, even if a much larger total should make it exceed the probable error. Those who have inherited the throne must, on the average, have lived slightly longer than those who have not. A long life must favor the chances of inheritance. If the sovereigns have been longer lived, then they have had that much more time in which to distinguish themselves. Another point is that for all forms of genius (painters, poets, scientists, authors, etc.) and for the mentally abnormal as well, it has been claimed that the probabilities favor the firstborn beyond chance expectation. But some of these results have been questioned.

At any rate this does not concern the contention which I have made that there is no marked or easily measurable influence of opportunity on sovereigns, at least as arising from their official position.

Here then is an attempt to measure the rela-

tive influence of heredity and environment, not in a general, but in a special way. As I have been pointing out for several years, "the heredity *versus* environment" muddle can not be clarified except by making everything into problems of differences.

The study of the lower organisms may give for human heredity, very erroneous conclusions. The lower organisms are much more modified by environment than are the higher. If we are to make the science of eugenics accurate and accumulative, we must in every case, first decide what human differences, because of their importance, are interesting; then keeping the heredity factor constant, we should experimentally alter the environmental; or keeping the environmental the same, experimentally alter the heredity.

There can be no general answer to the time-honored controversy; but there may be a special answer to each separate, pragmatically conceived question. There may or there may not be. We can not tell until we try.[3]

Here it is not a general question whether opportunity has had any influence or not. It is a special one. Have we a right to say that there have been proportionately more great men among kings than among commoners because of the environment of kingship? The answer is that as far as we know at present the differences of environment have had absolutely nothing to do with it.

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[3] For a fuller discussion see "Separating Heredity from Environment," *American Breeders Magazine*, Vol. II., No. 3, 1911, and "The Influence of Monarchs," pp. 227–229 and 290–293.

OCCURRENCE OF BACTERIAL BLIGHT OF ALFALFA IN THE SALT LAKE VALLEY, UTAH

THE bacterial disease of alfalfa studied by Sackett[1] in Colorado has already done considerable damage in the Salt Lake Valley, Utah. So far as the writer knows, this disease, which is due to *Pseudomonas medicaginis* Sackett, has not been definitely reported from Utah, although Heald[2] states that "what appears to be a similar disease has also been reported from Utah, New Mexico, Nebraska and Kansas." There is sufficient evidence to warrant the statement that the bacterial blight of alfalfa has been prevalent in the Salt Lake Valley for some time, and, no doubt, the poor stands, as well as the many weak plants, are due to this disease. It is certain that this disease has caused more injury than the crown gall disease [*Urophlyctis alfalfæ* (v. Lagerh.) P. Magnus], recently reported by the writer as occurring in the Salt Lake Valley, and is certainly as injurious as the alfalfa weevil (*Phytonomus murinus* Fab.). In the past this disease has been mistaken for smoke injury due to the smelters, and it has also been reported as "alkali burn." That this disease could have escaped notice is singular, because the symptoms are as definite as those of the pear-blight disease.

The water-soaked, semi-transparent, yellowish to olive-green appearance of the stems, together with the presence of small droplets of a thick bacterial ooze and the weakened and partially drooping plants are the unmistakable symptoms of the disease in the incipient stages. Finally the stems become brownish-discolored or blackened, and very brittle. When the stems are attacked the foliage soon becomes chlorotic, finally turning a dirty white in severe cases. The leaves then become dry and brittle. When small pieces of the tissue of the diseased stems or leaves are mounted in water on a slide, enormous masses of the organisms may be seen by the naked eye issuing from the tissues. There is absolutely no difficulty in securing pure cultures.

The presence of the alfalfa weevil in the Salt Lake Valley is a factor in the distribution of this disease. While it is known that stomatal infections may occur, by far the greater number of infections take place through openings in the epidermis produced by insect punctures and severe frost injury. It has been noted that

[1] Society American Bacteriologists, Boston meeting, December, 1909. SCIENCE, N. S., XXXI., 553, 1910. Colorado Agricultural Experiment Station Bull. 158, 1910.

[2] Phytopathology, Vol. II., No. 1, page 12.

where the disease is present in a field the greater infection occurs where the alfalfa weevil is also present. This disease is so injurious that fully 80 per cent. of the first cutting may be lost on account of it. However, while the chief damage is usually noted in the first cutting, the plants may be seriously injured in the crowns and roots, thus causing entire plants to be killed.

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SALT LAKE CITY, UTAH,
May 16, 1914

FURTHER NOTES ON TAMARISK

JUDGING from Mr. Carleton's remarks[1] and the writer's experience *Tamarix gallica* is another of those interesting plants that will grow in very dry as well as in exceedingly wet places. This species is extensively planted at Belle Isle, Vermillion Parish, in the broad coastal marsh of Louisiana. The soil here is always saturated with water and is subject to inundation by exceptional tides. The plant is known as salt-water cedar, and its main use is for firewood. Little of that commodity is needed in this austral locality, and sections of the limbs of *Tamarix,* in size from the thickness of a finger to that of the wrist, answer every purpose. The plants are pollarded and closely pruned but quickly produce a new crop of firewood.

W. L. MCATEE

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

[1] SCIENCE, N. S., XXXIX., pp. 692–694, May 8, 1914.

A FACTOR FOR THE FOURTH CHROMOSOME OF DROSOPHILA

A NEW character has recently appeared in *Drosophila* in which the wings are "bent." The factor concerned does not fall within any of the three groups of linked factors so far described. There are four pairs of chromosomes in *Drosophila* (without taking into account possible complications of the *XY* pair). The number of chromosomes now corresponds therefore with the number of independent groups of factors. The correspondence goes even further than number, however, for the sex-linked group is known to be distributed with the *X* chromosome, and all the groups correspond in their size-relations with the chromosomes, there being three large groups and one small, just as in the case of the chromosomes. The factor for "bent" forms the small "group" by itself, and accordingly may be considered to lie in the small chromosome.

HERMANN J. MULLER

DICKERSON[1] ON CALIFORNIA EOCENE

Two brief but valuable papers by Mr. Dickerson call attention to the fact that the apathy with which the Eocene of California has been treated since Gabb's time is less on account of any last word having been said on the subject than the overshadowing economic importance of the later Tertiary horizons of the state.

The use of the name Tejon to embrace all the post-Martinez Eocene of the Pacific coast and the recognition of the section south of Mt. Diablo as a standard for this formation can hardly meet with general approval. It appears that this section is composed exclusively of beds belonging to a formation stratigraphically younger and separated from the horizon at the type section in the Canada de las Uvas near Fort Tejon by several thousand feet of strata as well as a considerable time gap.

The writers[2] have shown that in Oregon and Washington the Eocene may be divided into three faunal divisions, the Chehalis, Olequa, and Arago or Ione formations. The

[1] Dickerson, Roy E., "Fauna of the Eocene at Marysville Buttes, California," Bull. Dept. Geol. Univ. of California, VII., p. 257–298, Pl. XI.–XIV., 1913; "Note on the Faunal Zones of the Tejon Group," *loc. cit.*, VIII., No. 2, p. 17–25, 1914.

[2] Arnold, R., and Hannibal, H., "The Marine Tertiary Stratigraphy of the North Pacific Coast of America," *Proc. Am. Phil. Soc.*, LII., No. 212, p. 559–605, 1913.

Chehalis formation is characterized especially by *Venericardia horni* Gabb, *Meretrix californica* Gabb and an austral flora, the Olequa formation by *Pecten* (*Chlamys*) *landesi* Arn., *Venericardia horni* Gabb, and a tropical flora, and the Arago or Ione formation by *Turritella merriami* Dickerson, a form of *V. horni* with obsolete ribs (variety *aragonia* A. & H.) and a tropical flora.

The Chehalis and Olequa horizons lie in juxtaposition, and constitute the coal-bearing Eocene of western Washington. The upper or Olequa horizon has not been definitely recognized in Califoria, but the lower or Chehalis horizon is the apparent equivalent of the Eocene of New Idria, Salt Creek, Coalinga, Canada de las Uvas, Simi Valley, Topa Topa Mountain, Santiago Canyon, and presumably Rose Canyon near San Diego, as well as the plant-bearing shales near Lake Elsinore.

Looking at a map of the Pacific coast, it is evident that these deposits were formed in two embayments. The Puget Basin covered western Washington from the south base of the Olympic Mountains to the Columbia River, an arm reaching northward to Vancouver, British Columbia, while the main body extended inland to the foot of the here more recently developed Cascade Range and probably farther, for the Swauk formation of central Washington apparently represents deposits formed near the east margin of the same great stretch of marsh and estuary. The Tejon basin covered the San Diego mesa, the Los Angeles coastal plain, and crossed the San Gabriel and Santa Ynez Ranges in a long arm extending into the San Joaquin Valley and northward through the Coast Ranges as far as New Idria. As the deposits are usually more or less marine in origin, it is evident that this embayment was rather of the type of an open roadstead than the partly detached brackish estuary in which the Washington deposits were formed.

The Arago or Ione beds represent a horizon younger than any Tejon recognized in the Tejon or Puget basins. They do not occur in juxtaposition, but are developed in different districts, lying indiscriminately across older rocks. The Arago or Ione beds have been recognized in three basins, the Crescent basin, a narrow arm extending inland along the north base of the present Olympic Mountains to the vicinity of Port Crescent, Washington; the Arago basin, a broad open roadstead covering the Coast Range, Williamette Valley, and Umpqua basin of Oregon, the marine deposits of the south and west being gradually replaced to the north and east by débris from the Eocene volcanoes of the Cascade Mountains; and the Ione basin which extended inland between the north terminus of the Mount Hamilton Range and the higher Coast Mountains of northern Lake County, to lap the base of the Sierra Nevada. This embayment spread southward through the San Joaquin Valley to Pacheco Pass and San Joaquin Canyon, and north to Oroville and perhaps beyond. Most of the deposits were laid down in a sea of considerable depth as shown by the glauconitic sandstones and the paucity of coal beds, but there is a tendency for the marine beds of the eastern border at Merced Falls, the Mokelumne River south of Ione, and South Oroville Table Mountain to grade up into the rhyolitic tuffaceous plant beds between Ione and Carbondale and at Oroville Table Mountain, while in the district about the Big Bend of Pit River only deposits of the latter type are known.

As already noted, the Tejon type section in the Canada de las Uvas was taken in beds of the Tejon embayment, and since the name Tejon series has always been used in a loose sense the writers have proposed to retain it in such a way as to cover the Chehalis and Olequa formations of the Puget embayment, as well as the deposits of the Tejon embayment.

The Arago or Ione beds, occurring as they do in basins distinct from those in which the Tejon series is developed and being formed at a different period, must be treated as a distinct division of the Eocene. The earlier name is the Ione formation,[3] the Arago having been given several years later.

[3] The gravels underlying the mud flows of Marysville Buttes often mapped as Ione are of very much later age.

If the section south of Mt. Diablo is considered as a standard for the Ione of California it would be interesting to see whether the divisions admitted by Dickerson may be recognized elsewhere. The series is at many points, especially in southern Oregon, extremely thick, and might easily include more than one faunal horizon as yet unrecognized.

On the whole the writers are in hearty accord with Mr. Dickerson's results. A most valuable point brought out is the discussion of the depths of the water in which the various beds were deposited. It should be the incentive to further studies of this sort which have been altogether too much neglected.

RALPH ARNOLD,
HAROLD HANNIBAL

SCIENTIFIC BOOKS

Artificial Parthenogenesis and Fertilization. By JACQUES LOEB. The University of Chicago Press, Chicago, Ill. 1913. Pp. viii + 306. 39 tables and 86 figures. Price \$2.50 net; \$2.68 post-paid.

As stated in the preface, "Artificial Parthenogenesis and Fertilization" is in reality the English translation of an earlier work, "Die Chemische Entwicklungserregung des Tierisches Eies," enlarged and brought up to date by incorporation of the recent research in the field of development. The realm of artificial parthenogenesis is not a narrow one, by any means. It involves problems of wide physiological interest, the action of ions on tissues, the natural death of cells, immunity, hybridization and organic oxidation, a process coextensive with life itself. Thus we have chapters devoted not only to the history and methods of artificial parthenogenesis, but on "The Relative Physiological Efficiency of Various Isosmotic Solutions"; "Chemical Constitution and Relative Physiological Efficiency of Acids"; "Condition for Maturation of the Egg"; "Heterogeneous Hybridization"; "Hydrolytic Processes in the Germination of Oil-containing Seeds," etc. The chapters contain a mass of detailed results, chiefly those of the author, obtained by almost continuous experimentation over a period of fifteen years. Each is a model of what the experimental method should be—the observation of certain facts, the formation of provisional hypotheses to explain these observations and, most important of all, the subsequent testing of the hypothesis by experiment. Only in this way can a mass of unrelated details be welded together into a logical whole presentable to the general reader, as well as the special student of the field of development.

The more recent discoveries are naturally of greatest interest. One is impressed in reading Loeb's book, with the great variations in the conditions for development among closely related forms—variation in factors which we should expect to be fundamental and universal. Thus we find that the eggs of *Strongylocentrotus purpuratus* do not develop in neutral sea water, but only in slightly alkaline sea water, whereas the eggs of *Arbacia punctulata* develop not only in neutral, but even in a slightly acid medium. The response of eggs to different methods of artificial parthenogenesis varies greatly. All gradations occur from species which are normally parthenogenetic or occasionally parthenogenetic through those ready to respond to any method, even mechanical agitation, to forms developing only after very special treatment or not responding to stimulation of any kind.

A similar variation exists in regard to the oxidative process, which is of particular interest for the theory of development. The rate of oxidation in sea-urchin eggs increases sixfold after sperm fertilization or artificial fertilization. Apparently the sea-urchin egg has come to a rest because something inhibits its oxidations and the sperm can set them going again, with consequent development. With this hypothesis in mind we turn to the starfish egg, only to find that here the oxidations do not increase after the sperm has entered. The starfish egg undergoes a certain amount of development, maturation, in sea water and then comes to rest. The entrance of sperm or treatment of some

kind is then required to continue development despite the fact that the oxidations are going on to their fullest extent. That it is their fullest extent is indicated by the interesting fact that even complete cytolysis of an egg by saponin will not further accelerate its rate of oxidation.

Loeb analyzes the effect of the sperm in initiating development into two factors—first, the sperm contains a lysin, not readily diffusible into the egg of the same species, but readily so into eggs of other species, which produces a surface cytolysis. The surface cytolysis leads to membrane formation in eggs which form fertilization membranes as part of their normal development. Foreign cells and foreign fluids may contain similar "lysins," but eggs are immune to lysins of cells of the same species because they are impermeable to them. Hence they must be carried in by actual penetration of the spermatozoon. In most eggs, especially sea urchins, a second substance must also be carried into the egg to prevent the destructive effect caused by superficial cytolysis. Some eggs, *Asterina, Polynoë* and *Thalassema,* do not require the second corrective factor, due possibly to the fact, as Loeb suggests, that they already contain it or automatically form it. Again we note variability in an apparently fundamental point. The effect of the lysin is imitated by the various membrane-forming substances which if too concentrated lead to complete cytolysis of the egg. The effect of the second substance is imitated by the various correcting agencies, hypertonic sea water, low temperature or a prevention of oxidations by KCN and chloral hydrate.

The lysin, the membrane-forming substance, is the essential in causing development. How does it act? At present only suggestions can be made. A possible method and a very simple one would be the removal of some substance which prevents development. This view which has been suggested and discussed by Loeb and other authors seems the most probable one to-day. The problem of fertilization becomes as much a question of what causes the egg cell to cease development in a certain stage as of the cause for its further development by the entrance of a spermatozoon. In physiological terms we may say that the stoppage of development appears to be due to an inhibiting substance, that it is an auto-narcosis. The lysin in the sperm or any artificial method of causing development, even the prick of a needle, allows the inhibiting substance, the narcotic, to pass out. This result is possibly obtained, although Loeb does not definitely uphold this view, through increase in permeability of the egg. As already mentioned oxidations are not diminished in the resting condition of the starfish egg and it is interesting to note, as shown by Loeb, that oxidations in artificially narcotized cells are likewise not diminished. Narcosis is not due to asphyxiation but is probably due to decreased permeability. Certainly research along the line of cell permeability, especially functionally conditioned changes in permeability is the most promising field for a solution of the problem of development, as of many other biological processes.

The reader interested in developmental mechanics will be well repaid by a close study of Loeb's book. Here is collected in condensed and readable form the results of many years' study together with conclusions and ingenious hypotheses which stimulate to additional discoveries along these and other lines.

E. Newton Harvey

Princeton, N. J.

Rocky Mountain Flowers: An illustrated guide for Plant-lovers and Plant-users: with twenty-five plates in color, and twenty-two plates in black and white. By Frederick Edward Clements, Ph.D., Head of the Department of Botany in the University of Minnesota, and State Botanist; Director of the Pikes Peak Alpine Laboratory, and Edith Schwartz Clements, Ph.D., Instructor in Botany in the University of Minnesota and in the Pikes Peak Alpine Laboratory. The H. W. Wilson Company, White Plains, N. Y., and New York City, 1914. Octavo, 392 pp. ($3.00.)

Tourists in the Rocky Mountains have waited long for such a book as this, and we hazard the guess that it will be eagerly accepted by them as the manual which will enable them to recognize and name the flowers they find on the high plains and in the mountain canyons. For such people the colored plates of approximately two hundred species, and the black and white plates, of not far from three hundred more, will prove most helpful. But aside from tourists and other summer residents of the Rocky Mountains there is a still larger class of people who will welcome this attractive book. For, contrary to the opinion of many who have never crossed the Great Plains, there are schools and colleges and universities with their students and teachers interested in the plant life about them. And to these we may add an increasing number of people who are interested in plants because they love them. In fact, these great highlands of the United States are coming to contain very many people to whom such a book as this will appeal very strongly. We can not imagine a better book for the high school libraries of the west, or for that matter for the libraries of the western colleges and universities. The beautiful plates, which were made by the junior author, must appeal to every pupil with any esthetic sense, as they must also to many cultured people outside of the schools.

The chief features of the book are its general key to families, in which the treatment is distinctly non-technical, accompanied by a chart of relationship that should make the determination of the family relatively easy. Following these are the Dicotyledonous orders, and families, followed later by the Monocotyledonous orders and families, with keys, again, to the genera, and later to the species. Here a useful feature is emphasized in giving rather fully the etymology of the generic names, a matter that will be appreciated especially by those who are not privileged to be in the classes of scholarly teachers. Each genus is briefly characterized, and following this the species are indicated by a key in which as many descriptive features as possible are emphasized. In passing it should be pointed out that the plates always include related plants, so that family relationship is thus emphasized. The black and white plates, again, emphasize the more difficult species, notably those of the grasses and sedges. This fact will add much to the usefulness of the book.

An introduction of nine pages gives some idea of "the general lines of the evolution of flowering plants from the ancestral ferns," and suggests "the relationships of the various groups." The discussion leads up to the "chart of relationship" mentioned above.

In the preface the authors have something to say about "species" that will show the scientific reader that they have been thinking of the problem of species limits. Of course this preface was not written for high school pupils, nor indeed for the tourist of limited scientific training, but for botanists this short preface will be found to contain some suggestive thoughts.

We are told by the authors that the range of the book includes "Colorado, Wyoming, most of Montana, northern New Mexico, eastern Utah, and western North, and South Dakota, Nebraska and Kansas," and no doubt it may be profitably used in a considerable area oustide of these limits.

The authors are to be congratulated upon the successful completion of this notable work.

Charles E. Bessey
The University of Nebraska

The Life of the Mollusca. By B. B. Woodward. London: Methuen & Co. 1913. 12mo. Pp. xii + 158. Pl. XXXII., 1 map.

This volume is one of a popular series intended to summarize existing published knowledge on the subject of which it treats, and not to present fresh information or new researches. It is distinctly not ecological, and, perhaps in deference to British prudishness, omits the existing data on the reproduction of the pulmonates, a body of facts which have more bearing on the life of these mollusks and have been more thoroughly observed than any other phases of molluscan life.

The plan includes a (somewhat obsolete) system of classification, a chapter on geological history, one on distribution (such as can be obtained from existing manuals), on reproduction (omitting reproductive acts), on food, evolution, instinct, intelligence and uses, with an index.

Taken for what it is, a compilation from the literature for popular use, it should not be too harshly criticized, and in fact presents a useful compendium of widely scattered data, not elsewhere brought together.

It is well illustrated, chiefly by reproduction of the plates of the well-known "Manual of the Mollusca," by S. P. Woodward, first published in 1850, and in its time easily the best of the smaller manuals of the mollusca.

Taking into consideration the purpose of the book, the chief criticism which in justice to the reader we feel should not be suppressed, touches on the too ready acceptance by the author of some statements by others which stand in desperate need of confirmation.

For instance the assertion that the murices utilize the spur or projecting spine of the aperture of the shell to pry open bivalves which they intend to devour, is almost precisely on a level with the statement that a man can sit in his own lap, and would be possible only in space of the fourth dimension. In the most charitable view the author of this assertion united to a lively imagination very imperfect observation. Such notions touch the imagination of the ignorant, but have no proper place in scientific literature.

Also the assertion that the shell-bearing Pteropoda are derived (p. 56) from the *Bulla*-like Tectibranchs (originating with an anatomist of limited experience with mollusks) is hardly compatible with the ascertained facts that shell-bearing Pteropods occur in the Cambrian; while the Bulloid Tectibranchs first appear near the close of the Carboniferous (p. 47).

Here and there such questionable statements mar the generally high average of accuracy of this little compendium, but, on the whole, it will fulfil a useful purpose.

WM. H. DALL

PRINCIPIA ATMOSPHERICA

1. *Upper Air Calculus and the British Soundings during the International Week* (May 5-10), 1913. By W. N. SHAW. *Journal of the Scottish Meteor. Soc.*, Vol. XVI., No. XXX., p. 167.
2. *Principia Atmospherica.* A Study of the Circulation of the Atmosphere. *Proc. Roy. Soc. Edinburgh.* Read December 1, 1913.
3. *Principia Atmospherica.* An address before the Mathematical Society, January 7, 1914. Privately printed.
4. *The Interpretation of the Results of Soundings with Pilot Balloons. Quar. Jour. Roy. Meteor. Soc.*, April, 1914.

In these four recently issued pamphlets, Dr. W. N. Shaw, the progressive director of the British Meteorological Office throws wide open a new door in aerology through which we seem to catch sight of that great desideratum, the forecast based on definite laws, or perhaps it would be the part of wisdom to say, definite foreknowledge of the structure and energy distribution in "highs" and "lows" in connection with the flow of air at different levels.

It is only a short time since W. H. Dines, studying numerous upper air observations, came to the conclusion that the differences of pressure at the earth's surface were of the same order of magnitude as those at a height of nine kilometers and therefore the distribution must be regarded as controlled by conditions at the base of the stratosphere. In studying this remarkable result, Shaw examined the physical conditions necessary for the building up of pressure between points at the same level in two verticals and found that the difference in the influence of the stratosphere and troposphere is attributable to the characteristic difference of temperature. He establishes a formula for the increase of pressure difference per meter of height and a second equation which gives the gradient wind velocity at any level. This latter is used to explain the variation of wind velocity with height and in particular the falling-off in velocity in

the stratosphere. In the second paper Shaw carries the application of the equations somewhat further and making certain assumptions works out temperature and pressure from wind velocity at successive heights. There is also a statement of certain axioms or laws of motion and applications of the laws in practical meteorology. The laws stated briefly are (1) relation of motion to pressure; (2) computation of pressure and application of gaseous laws; (3) convection, which is expressed as the descent of colder air in contiguity with air relatively warmer; (4) the limit of convection, defined as that portion of the atmosphere where there exists a sensible fall of temperature with height, and (5) the law of saturation.

The irregular variations in temperature-difference as given by a pair of soundings with registering balloons; and the curious local irregularities of wind disclosed by pilot balloon ascents, hitherto explained as uncertainties of observation, are now in Dr. Shaw's opinion seen to be important as indicating complex structure of the atmosphere. If Shaw's reasoning is correct then it may be possible to get from one pilot balloon as much information for practical purposes as from three registering balloons. The distribution of isobars at 4 kilometers as computed by Teisserenc deBort is also considered and the law of convection applied. One sentence is significant and may be quoted. "All the main air-currents of the globe have pressure-distributions to guide them. They can not usefully be called convection currents." There is also a most suggestive reference to the flow of air down the Arctic and Antarctic slopes. It appears likely that whenever in a mass of air, temperature-fall is in the opposite direction to pressure-fall, great change in the horizontal distribution of pressure underneath is the result; and many of our local variations of pressure may fairly be attributed to the reactions which these cold masses of air offer to the attempt (in the end futile) of the upper air to steer them round the pole from west to east. If left to themselves they would circulate in opposition to the circulation of the upper air with which they are in perpetual conflict.

With regard to tropical revolving storms, Dr. Shaw holds that these must be considered under a different head, namely that of turbulent motion, and intimates that papers are forthcoming on this subject.

The third paper is largely made up of tables for facilitating computation in problems like those referred to above.

In the fourth paper our author deals with examples taken from typical cases of atmospheric structure selected by Mr. Cave for illustration by means of photographs of models in the "Structure of the Atmosphere in Clear Weather." Five distinct classes are considered. He introduces a new conception, that of operative pressure. How this is produced does not appear but if its existence be granted and the thermal structure of the underlying air, then the deductions drawn follow with mathematical precision. Instances of irregular distribution of temperature are explained and in the case of one marked inversion it is imagined that the construction was formed above a pool of cold air such as would be found over fog. The result of recent work is to show that as regards the weather of the present and the immediate future, the operative pressure distribution and the thermal structure of the atmosphere between it and the ground ought to be regarded as independent variables.

Shaw looks forward to the issue of maps of the upper levels wherein cloud observations and pilot balloon data will show what the actual circulation at a given level is. From these we may estimate the effect on pressure distribution in lower levels.

The papers taken together give a working plan so far as general atmospheric motion is concerned and form a distinct contribution to the solution of the problem of the life-history of cyclones and anti-cyclones.

ALEXANDER McADIE
BLUE HILL METEOROLOGICAL OBSERVATORY

NAVIGATION WITHOUT LOGARITHMS[1]

CAPTAIN GUYOU, of the French navy, a mathematician of note, author of valuable

[1] "Nouvelles Tables De Navigation," Emile Guyou. Berger-Levrault, Editeurs, Paris.

works dealing with the problems of navigation and member of various learned societies, has devoted part of his time since his retirement to producing tables from which a "line of position" (Sumner line) can be worked and the ship's position thereon approximately determined with the least labor and in shortest time.

The tables are preceded by a condensed explanation for the benefit of those who wish to understand their mathematical development; but the many practical and efficient navigators who bother little with theory will be interested to know what Captain Guyou does, without having to concern themselves as to how he does it.

Gird up your imagination and conceive the world and the heavenly bodies as standing still; suppose, further, that your ship is connected with a heavenly body not directly overhead—the sun, for instance—by a steel rod having a universal bearing where attached to the ship and another where attached to the sun. Start up your engine and let the wheel alone! The ship will be so controlled by the rod that she must describe an enormous circle on the face of the waters, having for its center that point on the earth's surface at which the sun is then in the zenith. Meanwhile, the rod describes an enormous cone with the sun at the apex, and when we consider that the sun's altitude, or height, is measured by the angle enclosed between the rod and the base of the cone (roughly), we can realize that an observer on board, taking the sun's height with a sextant at frequent intervals, will get the same height all the way around the circle.

The foregoing must be qualified in practise because the world does not stand still and the ship is not going to sail on a circular course; true, she is on the circumference at the moment of observation, but she may be crossing it at any angle because the position of the center of the circle and the direction in which the circumference trends depend upon the sun and not upon the ship.

If the ship be at rest, the observed altitude of the sun will change continually from hour to hour because of the apparent motion of the sun in his diurnal course. If the ship be in motion, the observed altitude of the sun will likewise change from hour to hour not only because of the sun's apparent diurnal motion, but also, although by a comparatively small amount, because of the fact that the ship is under way pursuing a certain course and making a certain rate of speed. It is evident that she may be considered to be crossing a circumference at any moment and that all sun observations *taken at that moment* from ships on different parts of that circumference will show the same altitude.

Two problems present themselves!

First: To find the circumference.

Second: To find the point at which the ship was crossing it when the observation was taken.

They have been dealt with in various ways. An able French admiral, Marcq de Saint-Hilaire, evolved an admirable solution by working out the distance from the dead-reckoning point—almost always more or less erroneous—to the circumference; his method may be outlined as follows: the navigator measures the height with a sextant, notes the time, then *calculates* the height he would have gotten at the dead-reckoning point at the moment of observation. If the two heights agree the dead reckoning may be accepted as correct, for it coincides with the circumference; this occurs but rarely; as a usual thing the dead-reckoning point falls several minutes (of distance) outside the circle or within it, two heights result, and the difference between them enables the navigator to work out the error in distance from dead reckoning to circumference. This solves the first problem!

The solution of the second is simpler because the dead reckoning is sufficiently reliable to limit to a few sea-miles that portion of the circumference at some point in which the observation must have been taken. Since the circle is very large this small portion of circumference may be accepted as a straight line. It is the navigator's "Line of Position" and the ship's crossing point thereon is closely approximated by the direction of the center

of the circle from the dead-reckoning point, which direction—since the sun is the zenith of the circle's center—is rendered by the azimuth.

But this method, though far the most desirable theoretically, involves the danger of error, the time, labor and irritation inseparable from an appalling array of logarithms—I rejoice that I am not called upon to express the sentiments with which a tired and hungry man in oil-skins regards logarithms—the calculation of height at the dead reckoning point calls for a half dozen, the azimuth for three or four more, and these operations are followed by an excursion into trigonometry to localize the result; which result, if you are an amateur, will doubtless be wrong, while, if a professional, you will not have tried it.

With Captain Guyou's tables one enters with true height and declination in a page devoted to the approximate latitude and takes out two numbers, turns to a page devoted to the approximate hour-angle and takes out two more. With these numbers he does one small sum in addition and and two in subtraction, then rules off the ship's position on the chart.

One can only admire the lofty unconcern with which Captain Guyou juggles distances, especially as he juggles them accurately. One of his circles can enclose the greater part of a hemisphere but he does not hesitate to slide it down until the dead-reckoning latitude coincides with the equator where he performs his mathematical feat with the two heights before coolly sliding the circle back again. Of course the objection at once arises that the navigator would not have gotten the same observed and calculated heights on the equator that he did get in higher latitudes, but here Captain Guyou's versatile resource comes into play, for the navigator *would* have gotten the same number of minutes of difference between the two heights (expressed in minutes of the respective latitudes). This difference, as we have seen above, yields the error in distance between dead reckoning and circumference and from it, in connection with the azimuth, the position can be worked out.

But Captain Guyou does not slide down to the equator merely in search of the above-mentioned error. He has another purpose and it is indeed ingeniously accomplished: we all know that the basis of navigation is the spherical triangle and that three parts of it—two sides and one angle, for instance—must be known before it can be solved. But tables calling for the combination of three known quantities throughout the extent of 90° of latitude and 360° of longitude would be ponderous and impractical. With only two known quantities these objections do not obtain, but two known quantities do not suffice to solve the problem. In drawing up his tables Captain Guyou has used three, of which the latitude is the third, and has employed a trigonometrical formula in which the required result is obtained by multiplying functions of the two other known quantities by the tangent of one half the complement of the third (the latitude). Since he has slid his circle down until the (dead reckoning) latitude coincides with the equator his latitude is 0°; the complement 90°; and the tangent $\frac{1}{2}$ $90° = 1$, which, as a multiplier, may be disregarded, thus reducing the known quantities which must be considered to two and rendering the tables practicable.

Little knowledge of navigation is required in using them. One must understand reducing observed height to true and correcting the declination for the moment of observation. It is of course necessary to be familiar with the varieties of time used at sea. In figuring, one must know, and observe, the difference between + and —.

These moderate requirements can be mastered in a few evenings and practise may then be begun over an artificial horizon, or otherwise, for the tables include a page of directions which cover all cases and can be blindly followed to a correct result. A general conception of the principles of navigation and the problems involved will come with practise and the necessity of thinking out one's mistakes, and, in a short time, a new hand should be able to work at sight with confidence and accuracy.

WALTER D. ROBINSON

SPECIAL ARTICLES

WHAT DOES THE MEDINA SANDSTONE OF THE NIAGARA SECTION INCLUDE?[1]

MOST geologists will agree, if stated as an abstract proposition, that a primary essential of any system of formational nomenclature is stability. In concrete examples, however, geologists display a marvelous facility in forgetting the importance of such stability or in ignoring any rules which might bring it about. This is well illustrated by the present status of the term Medina sandstone. In papers which have been read before the Geological Society of America during the last two years not less than three distinct meanings have been given to this term. The inconvenience of using any unit of measure which fluctuates in length from year to year would be no greater than that of using formation names for the geologic scale, which may differ by hundreds of feet in the thickness of beds included, according to the date or the individual author concerned. One can, of course, and in the present chaotic state of geological nomenclature generally does, in using a formation name, indicate whether he accepts Wm. Jones's or John Brown's definition of the formation. He may too have recourse to the booklets of formation names issued at intervals by some surveys, and ascertain what is the most fashionable length during the year in which he is writing for the formation in question. While these are possible and at present apparently necessary methods of indicating what one means when using a formation name, surely it would be better to adhere to a standard definition as we do for such terms of measure as foot and meter. Such a standard definition of a formation, of course, in no way precludes its subdivision as the progress of knowledge concerning it may dictate, accompanied by new names for the new sub-units. In the case of names which seldom reappear in the literature the inconvenience of changing meaning is comparatively small, but fluctuation in the meaning of such a term as Medina sandstone which occurs in most text-books on geology and in innumerable geological papers must lead to endless confusion. During the last decade a number of papers, perhaps the majority of those dealing with the Silurian of western New York, have made the term Medina include only the 100 feet of beds which are chiefly sandstones immediately preceding the Clinton; the others have included these and 1,100 feet of red shales below them as well in this formation.[2] Some inquiry into the reason for this wide diversity of usage and suggestions regarding the limitation of this term which the rules of nomenclature seem to indicate appear to be in order.[3]

[1] Published with the permission of the Director of the Geological Survey of Canada.

These rather surprising fluctuations in the thickness of the Medina sandstone in the same section began with Grabau's[4] and Chadwick's[5] proposals to restrict the name to the upper 100 feet of Hall's Medina sandstone, the lower 1,100 feet being named the Queenston shale by Grabau. In raising the question whether there were good grounds for restricting the term to the upper beds to which the sandstone is almost wholly confined, and giving to the lower shaly portion a new name, we are confronted by two subsidiary questions. (1) Is it ever permissible or desirable to restrict or redefine the name of a formation? (2) Was the Jas. Hall usage of Medina sandstone which Grabau's proposal supplanted identical with the application given the name by Vanuxem, who first used it? Examples both of contraction and expansion of the original meaning of formation names might be cited from the papers of various geologists. Whether the practise is approved or censured, there is abundant precedent for emendation of the original meaning of geologic names.

Before considering some of the conditions under which in the writer's judgment emenda-

[2] Bull. N. Y. State Mus., No. 114, p. 10.

[3] The writer wishes to acknowledge the privilege of examining before preparing this paper a manuscript by Dr. E. O. Ulrich which treats, among others, the question here discussed.

[4] SCIENCE, Vol. 27, April 17, 1908, p. 622.

[5] SCIENCE, Vol. 28, September 11, 1908, pp. 346–348.

tion is desirable we may revert to the second question. Vanuxem[6] introduced the name Medina sandstone into the literature in 1840, applying it to beds "called in former reports the red sandstone of Oswego." A much fuller description of the Medina sandstone was given by Vanuxem in 1842.[7] The formation is fully described in this report from exposures occurring in the Third District of New York to which Vanuxem's work was officially confined at that time. The name Medina which was given to it was taken, curiously enough, from a town about 100 miles west of the western limit of Vanuxem's field of work. Whether we consider the type section to be at Medina or in the third district where the particular section and exposures of the formation described are located, we must go to the latter region to discover just what is included in the term Medina sandstone. It is stated by Vanuxem to include sandstones lying between the Clinton above and the Oswego sandstone below. It is noteworthy that Vanuxem's definition of Medina contains no reference to shale. All of the occurrences of the Medina sandstone which he described in the third district are described as sandstone. The Medina as later defined by Jas. Hall[8] in western New York is mainly a shale formation comprising the 100 feet of sandstone just below the Clinton together with several hundred feet of red shale lying between this sandstone and the Oswego sandstone. The explanation of this apparent discrepancy between the two definitions appears to lie in the fact[9] that the upper or sandstone part of Hall's Medina extends considerably further to the east than the lower or shaly part. If Hall's lower Medina (Queenston of Grabau) does not extend as far east as the section described by Vanuxem then the original definition of Medina includes only the upper part of the beds ascribed to it by Hall, or that part to which this name is restricted by Grabau. Should this inference prove to be true, then Grabau's usage of Medina is really a return to the original meaning and not a restriction of it. In this case then it will be in order to consider whether any good reason can be offered for following the usage of Jas. Hall which makes the term include some hundreds of feet of beds which Vanuxem's definition excluded.

[6] Geol. Rept. New York, 4th Ann. Rept. of the Geol. Surv. of the 3d Dist., 1840, p. 374.

[7] Geol. of N. Y., Pt. III., 3d Dist., 1842, pp. 71–74.

[8] Geol. of New York, Pt. IV., 1843, pp. 34–57.

[9] Handbook New York State Mus., No. 19, Table 2, 1912.

It is proposed here, however, to consider the question on the assumption that the application of the name Queenston to the shaly, and Medina to the sandy part of Hall's Medina was an emendation of the original usage. We may first consider in doing this some of the circumstances which may justify or necessitate emendation of formation names. Under the rules of nomenclature formulated by the United States Geological Survey for the guidance of its members it is stated that "each formation shall contain between its upper and lower limits either rocks of uniform character or rocks more or less uniformly varied in character, as, for example, a rapid alternation of shale and limestone."[10] The application of this rule to the sediments included in Hall's Medina would not permit the use of the name in a formational sense, since the upper hundred feet and the beds below are entirely diverse in character, the latter being almost entirely a red shale, and the former chiefly a sandstone terrane. This lithologic difference between the upper and lower terranes, however, would not necessarily militate against the use of Medina in the group sense. It is in this sense that the name has been used lately by the N. Y. State Geological Survey[11] and by the U. S. Geological Survey.[12] There is, however, another and very serious objection to using the term in the group sense. Until recent years the upper and lower divisions of the Medina were supposed to represent the basal part of the Silurian. No

[10] 24th Ann. Rept. District U. S. G. S., p. 28, 1903.

[11] Handbook 19, 1912.

[12] Folio U. S. G. S., No. 190, 1913.

fossils have ever been found in the Queenston division in Western New York, but the discovery of fossils in these beds in Canada has led geologists who are familiar with the evidence to agree that they belong in the Ordovician system.[13] The fossils which have been found in the Queenston near Collingwood, Ontario,[14] place the Richmond age of the Queenston beyond question. The fauna of the upper Medina, however, as has long been known, places it in the Silurian. It is reported by Williams[15] that evidence in the shape of mud cracks at the top of the Queenston indicate a stratigraphic break between the Queenston shale and the succeeding sandstone which is the Whirlpool member[16] of the Medina. The Medina sandstone of Hall in either the group or formation sense therefore holds the anomalous position of including terranes which are not only unlike in physical characters, but which belong in different geological systems and are, moreover, separated by a disconformity. If beds can be properly kept in either the same formation or group which are so wholly unlike as the Queenston shale and the Medina sandstone of Grabau and which belong in distinct geological systems, then the terms formation and group have no value or definite meaning whatsoever in geology. It is a case where the growth of knowledge has made it impossible logically to hold to the earlier usage of Hall. In the light of present knowledge a restriction of the term so that it will not overlap systemic boundaries appears to be the only feasible method of employing it. Grabau's emendation of Hall's usage accords with the pronounced lithologic features which distinguish the upper 100 feet of the Niagara section from the beds below, and also with the later knowledge concerning the systemic relations of these beds. This application of the term Medina, which includes the Whirlpool sandstone as its basal member and the Thorold quartzite as its uppermost member, is the usage which the writer believes should and will prevail. The new name Albion which was introduced by the writer in the Niagara Folio[17] is synonymous with Medina as emended by Grabau. The latter term is therefore entirely superfluous and should be dropped from the literature.

Professor Chas. Schuchert's recent important discovery, that much of the "Clinton" of the old reports of the Canadian Geological Survey lies entirely below the base of the New York Clinton, must be taken into account in any revision of the Niagara section. Beds in this section which have shown a fauna too meager to encourage special study heretofore, and a lithologic differentiation too slight to appear to merit discrimination as separate members or minor lithologic units have taken on new significance and importance through the work of Schuchert, Parks and Williams in the region west and northwest of the Niagara section. One of these beds contains in the Ontario peninsula a rich and partly undescribed fauna which has been referred to by Schuchert[18] and Parks[19] as the Cataract fauna. The examination by the writer of a number of sections holding this fauna in connection with a review of the Niagara section has convinced him that all of the terranes associated with the Cataract fauna are represented in the Medina of the Niagara section. These have been given individual or member names in recognition of their physical and faunal contrasts by Dr. M. Y. Williams.[20]

13 Grabau, A. W., SCIENCE, Vol. 22, 1905, p. 529; Bull. 92, N. Y. State Mus.; SCIENCE, Vol. 27, 1908, p. 622. Ulrich, E. O., *Bull. Geol. Soc. Am.*, Vol. 22, 1911, pl. 27.

14 Foerste, Aug. F., *Ohio Naturalist*, Vol. 13, 1912, p. 47.

15 Paper read before the Geological Society of America, January, 1914.

16 Name proposed by A. W. Grabau, *Jour. Geol.*, Vol. 17, 1909, p. 238.

17 This name was suggested to the writer by the U. S. Geological Survey Committee on geologic names, but since in a Federal bureau suggest and command are convertible terms the writer may reasonably disclaim any responsibility for its use as well as for the usage of Medina there employed.

18 Paper read before Geological Society of America, January, 1913.

19 "Excursions in Southwest Ontario," Guide Book No. 4, pp. 127, 134.

20 Paper read before meeting of the Geological Society of America, January, 1914.

Any detailed discussion of the lithologic and faunal characteristics of these several terranes will be omitted from this paper since Dr. Williams will publish this data at an early date. These are indicated in the section given below which includes all of the formations cut by the Niagara Gorge.

Silurian	Lockport dolomite.
	Undifferentiated dolomite.
	Gasport limestone.
	De Cew limestone.[21]
	Rochester shale.
	Clinton formation.[22]
	Irondequoit limestone.
	Walcott limestone.
	Sodus shale.
	Medina formation.
	Thorold sandstone.
	Grimsby sandstone.[21]
	Cabot Head shale.
	Manitoulin beds.
	Whirlpool sandstone.
Ordovician	Queenston shale.

E. M. Kindle

[21] Name proposed by M. Y. Williams in paper read before the Geological Society of America, January, 1914.

[22] The term Clinton has been made to include in certain publications, among them Folio 190 U. S. G. S., the Rochester shale in addition to the beds hitherto known as Clinton. Until satisfactory evidence has appeared however, for such revision of the meaning of an old and well-established name there appears to be no reason for seriously considering either this proposed expansion of the term upwards or its expansion downwards as one geologist proposes. Frequent tinkering with the meaning of well-established names is not likely to serve any useful purpose. When revision of a name does appear to be required it should, in the writer's opinion, be accompanied by a full statement of all the evidence in the case and ample time for its discussion should be given before it is accepted. Such evidence has not appeared in this case.

NOTES ON A SHEEP THYREOID EXPERIMENT WITH FROG TADPOLES

At the time of the publication of Professor J. F. Gudernatsch's paper on thyreoid feeding experiments with the tadpole I was working with some tadpoles and having some extra ones I tried a short but similar experiment. I used

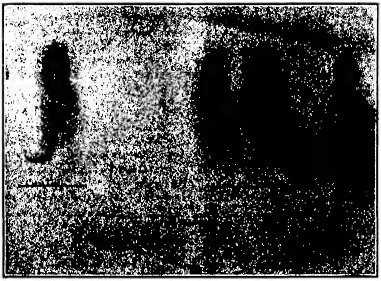

Fig. 1.

the large bull-frog tadpoles which had lain over one winter. The hind limbs had begun to develop and even to joint. They were divided into two lots, the one for control and the other for experiment. The experimental

lot was placed in pond water without any food except for such minute particles as may have been suspended in the water. They were fed daily some two grain Parke Davis & Co. sheep thyreoid tablets. The tablets were eagerly eaten by the tadpoles and except for appearing rather sluggish their behavior was normal. At the end of seventeen days the hind legs had developed much more and the fore left leg had come through and begun to joint. There seemed to be a slight development of the right forelimb, but it did not come through the operculum. The control lot which had been under the same temperature and light conditions and furnished with plenty of fresh pond water and food showed a slightly increased development of the hind limbs but no signs of any fore limbs. It became necessary at this stage to stop the experiment and the specimens were preserved in formalin. Unfortunately during moving all except a half dozen of the thyreoid fed lot and a few of the control were lost, but these have been photographed and are in good condition. I cut open the opercular wall on the right side of one of the thyreoid tadpoles and found a fore leg which had begun to develop but was much shorter and less advanced than on the left side where the limb broke through of its own accord. This experiment was too incomplete to have much significance, but it was interesting to note that the right fore limb only completely developed in every case of the thyreoid fed tadpoles and in the control lot neither fore leg developed at all. This experiment may be worth while by suggesting more thorough and complete work along this line. It may possibly also be suggestive of a method for right-handed people to become ambidextrous by eating sheep thyreoid.

PAUL ASHLEY WEST

BALTIMORE, MD.

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE ninety-seventh regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, May 5, 1914. Messrs. P. V. Cardon, G. P. Van Esseltine and A. B. Clawson were unanimously elected to membership.

The scientific program was as follows:

Professor Chas. O. Appleman, "The Physiology of the Rest Period in the Potato Tuber" (with lantern). To be published as a Maryland State Experiment Station Bulletin.

Dr. H. B. Humphrey, "A Recently Discovered Loose Smut of Rye" (with lantern). To be published in *Phytopathology*.

Mr. L. H. Dewey, "The Common Names of Plant Fibers."

Confusion in the names of textile fibers of vegetable origin causes uncertainty, financial loss and injury to the trade. The name "hemp" and its forms in other languages is the oldest name used to designate a plant fiber. This name is now used in many languages as a specific term to designate the true hemp, *Cannabis sativa*, to which in all instances it was first applied, and also as a generic term to designate all long fibers. This double use is confusing. The name sisal is also being used in a similar double sense. The following suggestions are made regarding the choice of names of fibers: (1) Names in most general use are to be preferred, providing they are not misleading. (2) The same term should not be used to designate fibers from different kinds of plants. (3) One name should be used to designate the fiber from one kind of plant, irrespective of the country where the plant is cultivated, or the manner in which the fiber is prepared. (4) Geographic names are objectionable in general terms. (5) Names that may be adopted directly in all languages are desirable. (6) Single words of not more than three syllables are best.

P. L. RICKER,
Corresponding Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT a special meeting of the Society held March 3 at the National Museum, Mr. W. E. Safford read a paper on "The Pan-Pipes of Ancient Peru." Mr. Safford became interested in the musical instruments of the Peruvians during a cruise along the west shore of South America in 1887. At Arica, near the northern boundary of Chile, he found in a prehistoric grave two sets of pan-pipes made of graduated reeds closely resembling the syrinx, or fistula, of the ancient Greeks and Romans. On terra-cotta vases were depicted men playing these instruments. Similar pipes made of bone were also found in Peru and northern Chile. Afterwards an entire orchestra composed of pan-pipes was observed. These were played in pairs, each performer having a mate with a com-

plementary instrument who played the alternating notes of the scale. That the pan-pipes of the ancient Peruvians were thus played in pairs is shown by pictures upon prehistoric vases, in which two instruments are represented as being connected by a long loose string. The pan-pipes observed were in most cases composed of 16 reeds, in two rows, one row superimposed upon the other, the row played upon by the performer having the reeds closed at the bottom, the outer row having reeds with an opening at the bottom. The smallest pair produced shrill notes like those of a piccolo; the largest pair, four times as long, produced deep tones much like those of a barrel organ.

At a special meeting of the society held March 4, at the National Museum, Dr. A. B. Lewis gave an address on his "Travels in the South Seas and New Guinea," illustrated with excellent lantern slides. The four years 1909–13 were spent in the interest of the Field Museum of Natural History of Chicago, studying the natives and collecting ethnological material, chiefly in Melanesia. Many of the islands are only partially explored. Fiji is the most civilized. The natives of Fiji are all professing Christians, and read and write their own language. Except the ordinary things of everyday life, there is little of the old left. The native Fijian population is about 90,000, the European 3,500, while there are 40,000 to 50,000 Indian coolies on the sugar plantations. New Caledonia was, for years, a French penal colony, and the natives are reduced to about 30,000 located on reservations, much as our American Indians. Some of the large islands of the New Hebrides are still wild and unsafe. To the ethnologist, Malekula is the most interesting. Over 20 languages are spoken on this one island, to say nothing of dialects. On the Solomon Islands there are probably not over 300 Europeans. New Guinea is the most interesting island of all. Except Greenland, it is the largest in the world, and the least known. New Guinea has never been crossed except near the ends. More time was spent on New Guinea than anywhere else. A considerable portion of the coast was visited and short trips made toward the interior. There are but few Europeans in New Guinea, the greater number, about 1,000, being in the British portion. A considerable number of these are gold-diggers. In German New Guinea there are about 200 Europeans, and in the Dutch portion not over 50. The old condition of warfare among the natives has been stopped as far as the government can extend its influence.

At the 473d regular meeting of the society, held March 17 in the National Museum, Dr. J. Walter Fewkes delivered an address, illustrated with lantern slides, on his "Egyptian Experiences." He considered especially the significance of certain parallelisms in cultural objects of the Stone Age of Egypt and the Gila Valley, Arizona. These resemblances he ascribed in part to the influence of irrigation. Through the cultural isolation of the Nile Valley in Neolithic times it was protected from outside marauders. Social advancement at the dawn of history was due to the influx of foreign ideas from the east and to the cooperative union of clusters of villages or nomes in order to more effectually irrigate the valley. This cooperation of the rulers of Neolithic Egypt led to the rise of a Great House or Pharaoh. To this cooperation in constructing irrigation ditches may be traced a system of enforced labor in which the Pharaoh not only acquired all cultivated land and the water which alone made agriculture possible, but also controlled all labor of the inhabitants. To these rights acquired from the rulers of the nomes in very early times, may be traced the powers exercised in constructing the magnificent monuments that are the world's wonders.

In Neolithic Egypt, there was a succession of villages strung along the river, each independent of the other, like a cluster of pueblos in Arizona. The remains of architectural constructions at this early epoch still remain and are sometimes, as at El Kab, well preserved. They are rectangular, massive, walled forts with an encircling wall of clay not unlike the compounds at Casa Grande in Arizona. Within these enclosures, in Egypt and Arizona alike, were mud or clay built temples, public buildings and houses of priests, while around them were clusters of the mean hovels in which lived the people like the present Egyptians. The dead were buried in neighboring mounds, placed with knees drawn to the chin and surrounded by mortuary offerings. These graves were rude excavations with floor of straw and roof of mud and boughs. Many resemblances between archeological objects from the Stone Age in Egypt and in the Gila Valley were pointed out. Among these are weapons, stone implements, pottery and its symbolic decorations, flat basket trays, bone and other specimens. Certain common conditions of environment and the necessity for artificial irrigation had led the Stone-Age people of different races, without connections, to develop a parallel culture.

Daniel Folkmar,
Secretary

SCIENCE

FRIDAY, JUNE 26, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE TREND AND INFLUENCE OF CERTAIN PHASES OF TAXONOMY[1]

"ENOUGH is sometimes too much," says the newspaper philosopher. I suspect some of you are thinking right now that we have already had enough systematic botany, but as briefly as I can I wish to try to show you that while it is true that we have already had too much, it is equally true that we have had too little.

Do not feel alarmed because of the magnitude of my subject. I shall not deal with it as a whole—only certain phases of it and their influence. Before attempting my main message may I voice a plea for the old-time systematic botany? It is of course primarily the handmaid to all of the other subdivisions of the science, but apart from that is it not in itself a desideratum of no small moment?

It trains the perceptive faculties, teaches orderliness, develops judgment and strengthens reason. It is therefore a cultural course of no small significance to all who take it and, as some of us know, the source of much pleasure to many. There is a saving grace in botany not found in most of the other sciences and this is exercised through taxonomy more fully than through all its other divisions combined. Systematic work for its own sake is distinctly worth while. It develops in the student or the amateur, who achieves a fair measure of success, a feeling of confidence in himself and gives that stimulus for further mental effort that only the conquering of a definite problem affords. In this respect it may be compared to mathe-

[1] Read before the Botanical Society of America at Atlanta, December 30, 1913.

matics, with the added advantage that the flavor of the pleasure derived recurs again and again as the fields and woods minister to his life, and spring, summer and autumn, yes, and even winter, in turn speak to him who understands their glad greetings of the passing years.

Let no one imagine that it is merely easy recreation for the *dilettante* in science. It is a man's job. Any one who succeeds in systematic work would measure up well in the philosophical subjects. Manuals and keys can be made only for those who can read as much between the lines as in them; those in whom the power of discrimination becomes strongly developed but who ease up its severity by the due exercise of judgment and reason.

Systematic botany furnishes to the average layman, who is scientifically inclined, a more continuous incentive for pleasurable and inspiring contact with the world about him than any other subject that claims to be worthy of his attention. It may be that it represents the primitive phase of our development, but does not all development begin with the primitive? That some never get beyond the primitive stage is neither here nor there. The same would be found true in any other subject whatsoever. I raise the question if it is not largely true that the best botanists we have or have had began their career as systematists? Were they not led into the subject by this door? Their love for plants, their desire to know them, determined their careers. We may be evolving greater and greater men in the science, but even these must of necessity touch at least the high points in the road by which the race of botanists have attained the crowning glory of the present. The recapitulation theory is as universally applicable as the theory of evolution itself.

Let us look a little farther into the careers of those whose names have come down from a former generation. To save time we will take a single example, one who was not only a systematist, but the peer of any in his generation in every other line. His name is known to more people in America, even a quarter of a century after his death, than that of any other botanist of any time or place. His bust found its way into the "Hall of Fame" because he did more than any one else to make it possible for people to know plants. He was admired and loved in his day and now because of his "Manual" and the accompanying "Lessons." Let it not be forgotten that he would still have been a distinguished botanist had he given no thought to systematic work. His grasp of structural and physiological problems was far in advance of his time, and who knows whether even his philosophy may not prove to have been more profound than some of his critics will now admit? Dr. Gray found his way into the hearts of the people and enriched their lives by opening for them a larger world than would otherwise have been possible to them.

It is true that in all the botanical fields there are great outstanding characters whom we do not ordinarily think of as systematists. These are, however, men or women who have rendered some signal service to the race by promoting its physical or economic welfare, but even these did much of systematic work before they were able to share with others the results of their achievements. Again, to take but one example, we have in Pasteur a name that will live so long as living things are subject to attack from microorganisms. He made the race his debtor, not only by what he himself achieved in bacteriology, but by opening the way into the new field. The work of his disciples in preventing and alleviating suffering in man and beast must also in part be accounted unto him for right-

eousness. Such men, however, were entering new fields and had to create descriptions and systems of classification as a foundation for their work and as a medium of communication with their fellows. Thus we have come back to the original statement, systematic botany is primarily the handmaid to all the other subdivisions of the subject.

Having said this much in commendation of taxonomy in general, kindly permit now a brief consideration of its trend and influence. If taxonomy and taxonomists are gaining in prestige and power, if the other departments of botany are each year being better served, if the average layman in the field finds it easier to know the plants themselves we may congratulate ourselves and say that all is well. If the reverse is true, something is radically wrong. A cancer is eating its way into a vital part of the body of our science.

Taxonomists were never so numerous nor more active than now. But all activity is not necessarily progress. Motion up and down may be spectacular and nothing more. Never were there so many devoting themselves to this subject professionally as at present. Literature is piling up volume upon volume. Before we can determine whether this is progress or recession we shall have to try to find the purpose of it all. The description and classification of plants is not in itself an end. It is a means to an end and that end not for the specialist himself, but rather for his colleagues in other lines and for the great army of intelligent men and women who love plants for their own sakes.

The reasons why people may wish to know plants are many, most of them entirely worthy. No reason is more legitimate than the mere desire to know that is almost universal until our method of education, or lack of method, kills the desire. Desire that is never satisfied dies afterwhile. The child asks, "What is it?" but when it has received the answer, "I don't know; stop bothering me," seventy times seven its interest either wholly dies or it seeks outlet in other channels. The furore of enthusiasm about nature study I fear has largely spent itself. The best statement of the purpose of nature study that came to me was "It aims to keep alive the child's tentacles of inquiry." Are we not largely failing in the attainment of this meritorious aim? If so, why? As I know our schools it is primarily because of the lamentable ignorance of all nature subjects by the teachers. Not only by teachers in general, but by those professing to teach botany in our high schools. A large majority of them wouldn't know an elm from a holly or an evening primrose from a lily. I have seen them by the score in my state and most of them came from outside schools of high standing where they had been trained in the cytology of plants that they never saw and in the ecology of plants that were left behind in the dreams and environment of yesterday. You may wonder how this relates itself to my subject. But listen! There is no reason for the existence of the professional systematist (apart from the growth and pleasure it yields him personally) unless his efforts produce results that make it more easily possible for others to know the plants in which they become interested. If he fails in this one thing he fails in all. May we not judge by the indifference of the multitude to our work; by the hopelessness of the amateur who tries to acquaint himself with the plants of his district; by the distrust of their results by even professed systematists, and by the none too well concealed cynicism of our colleagues in other lines, that we are failing in this? There seems to be nearly universal agreement

that it has become increasingly difficult for every one, for any one, to state with any degree of definiteness the correct name of any considerable number of plants. That we are in a muddle is evident. That we shall never be able to clear it up I do not believe. I shall not pretend, however, that I am wise enough to tell you how this is to be done. I very much doubt if any one knows at present just what to do next, but at least no harm can come from a free discussion. If we but knew just what has gotten us into our present plight it would simplify matters, but even then the application of the remedy would be difficult. We have each so long been a law unto ourselves that it will be impossible to secure any considerable unity of action at once. Particularly will this be true if there is no agreement that a remedy is needed. Some will feel so, in spite of the fact that a large majority of the botanists of this country would subscribe to the following arraignment: Our work has been analytic, not constructive. We have dismembered organisms and held up to view their component parts. We have been looking for differences and with such amazing success that the fundamental resemblances have largely escaped our notice. We have thus produced a *pot-pourri* that is the despair of every one except ourselves, and most of us do not know how to unravel our own mysteries.

I know this is a terrible charge to lay at our own doors, but perhaps it comes with better grace from one whom others have chosen to consider as *particeps criminis.* I dare not flatter myself that I have been even one of the chief offenders, but I acknowledge with humiliation that I have had a small share in producing the disaster that has overtaken us. I now stand before you thoroughly repentant. Would that I, like the reformed inebriate or the reclaimed sinner, could preach a gospel of reform with such fiery zeal that I should reach my erring brothers.

I know that only the dead make no mistakes. We have been passing through a period of great botanical activity and he who has not made many mistakes is not much of a botanist. It is better to have been alive for a decade and have to face our errors than to have been lying immobile blankly gazing at the stars for a millennium. However, there is no virtue in mistakes as such. Our endeavor should be the maximum of activity and progress with a minimum of error and lost motion.

That the names of plants have become so unnecessarily burdened with synonyms may be partly accounted for by the following considerations.

1. We have been so busy looking for differences that we have forgotten that classification is fundamentally based upon resemblances. A distinguished systematist has said that there are two kinds of botanists—"those who see differences and those who do not." I fear that some of the former class have had their discriminating faculties over-stimulated, since species have been founded upon and keyed out upon such valueless characters as one fourth mm. in the length of the stigma and scores of others even less evident.

2. We have thrown down the old concept of a species and we find ourselves in a jungle of illy defined forms out of which we shall never be able to come until we are willing to chop out the water sprouts that grow among and often from the loftier trees. Time tests many species. It is not conclusive, but it is very presumptive evidence against their validity if, as years pass and further collections are made, no other specimens are referred to them. In examining the material in any large herbarium one finds many such hermit sheets.

Let me suggest that there are also two kinds of species, those that exist more or less well defined in nature and those that have only an academic standing. Into which category the different ones will ultimately fall is not in the power of any one mind to settle, for we recognize the truth as expressed by Dr. Gray when he said:

> Species . . . are not facts or things, but judgments, and of course fallible judgments; how fallible the working naturalist knows and feels more than any one else.

We often hear of "critical species" and arguments are multiplied to defend their retention in literature. Surely it is true that some of them are valid and stronger even when held on avowedly technical characters than some of the supposedly evident ones that have long been accepted. Nevertheless, one can not help suspecting that the condition of many of these is so "critical" that they can not long survive the untoward conditions that a general upheaval in systematic botany will superinduce.

3. Some of the synonyms are the direct result of mistakes other than that of drawing overfine distinctions. To enumerate the countless causes for these errors is neither desirable nor possible. For each there is always an explanation, not necessarily an excuse. As already stated, error is inseparable from activity. Legislation that would limit publication to those having experience and who are working in a proper environment would be desirable but for two things: (*a*) It would cut off the future supply of systematists and (*b*) it is impossible of enforcement. Since prohibition is scarcely possible and surely not desirable, regulation might be attempted. Seriously, why should any one publish a species in a genus in which the known indigenous ones are not all clear to him, unless it be in a genus separable into strongly marked sections. In that case one might work with some assurance of certainty if all the species in the section were known.

4. It sometimes proves disastrous to assume, as is often done, an inherent improbability that the same species will not be found in districts widely separated geographically. Environmental factors must be reckoned with and these have a trick of repeating themselves in far distant and most unexpected places. Mistakes would be enormously reduced if every one was expected to definitely locate the proposed species in the genus, keying out the species if necessary, or only those of the section should its sectional relationship be apparent.

It is one thing to describe a plant and say (as I and others have done) "apparently not very near any of the hitherto known species." It is quite another to so describe it that it shall be properly contrasted with its nearest ally and its setting in the genus made evident.

It is always hazardous to publish in a large genus unless the examination of its content amounts practically to a tentative monograph. Take a genus at random, *Arnica* for instance, and even a superficial examination of the material in any large herbarium will reveal a number of good species each of which has been characterized by several during the last two decades, apparently because each felt free to assume, for instance, that Colorado and Washington were, for phytographical purposes, on different planets.

5. Another source of error lies in our adherence to different codes or to no codes at all. International law and comity are swept aside. Lawlessness always did mean anarchy in political and social life, and it has brought the same result in taxonomic nomenclature. The moral is not hard to find.

6. Our strength has not all been used in the promotion of constructive work. We spend too much time in criticizing the work of others or defending our own species. Naturally our own children are much better than others, but I doubt if we gain much by rushing to their defense whenever they are attacked. This species-*making* is merely for a day; species *characterization* is for all time. It is true that they may be thrown down to-day and erected to-morrow, but in the course of time the worthy will be established and the worthless will go to synonymy. To love our own is well, but to love them so well as to be willing to juggle the testimony is vicious. Pages and pages are wasted in criticism, recrimination and the imputing of wrong motives. The inexperienced alone are convinced by such speciousness. Those who have learned wisdom know that the attacked party, were he so minded, could put up an equally effective defense. Is it not better, however, to use all available time in productive work, knowing that nothing gets its final rating until established or disestablished by critical monographic work. The one thing we can not afford to be guilty of is insincerity. We simply must deal honestly with nature and justly with the work of our fellows. Personally I would rather my whole brood should perish than to save even the most promising by dissimulation or misrepresentation.

But I must not carry the inquiry as to causes further. There are many questions I had intended to raise, but time will not permit. I must condense into a few paragraphs just a thought as to the influence of the chaotic condition of taxonomy upon the progress of our science as a whole. Morphology, physiology, ecology and economic botany in its scores of applications have all gone forward by leaps and bounds, but it is (dare I say it?) in spite of, not by the aid of taxonomy. Our unstable nomenclature, involved synonymy, multitudinous, often "half-baked" species have produced the conditions described in this paper. The effect must of necessity be to retard, to discourage, to divert effort.

Now lest I be misunderstood let me say that taxonomic work has not all been misdirected—far from it. Keenness of observation and great powers of discrimination are noteworthy in the work done. It is not so much that what has been done should not have been done, but rather that much greater effort ought to have been made to relate recent work to that which had gone before. Synthesis should have followed so closely upon the analysis of the elements of our flora that duplications would promptly have been discovered and the relation of each element to the other detected and stated.

If we will keep in mind that technical systematic work does not exist primarily for its own sake; that when it ceases to be a means of culture and pleasure to others; that when it becomes burdensome to and unworkable by our fellow botanists in other lines—the chief reasons for its existence have passed, then we shall see more clearly what yet remains to be done. We need to popularize our subject, but not by writing down to those who know little and care less, but by classifying our work so that those who wish to know shall be able to understand. We need more local descriptive floras with well-made keys and illustrations. Our manuals have become too bulky; we cover so much territory that the species are necessarily very numerous. The more species there are in a given genus the more complicated the key and the slighter the differences that separate the species. We ought to have many handbooks and pocket manuals such as the one

Professor and Mrs. H. M. Hall have given us of the Yosemite.

We have had a feeling that our manuals must cover vast sections of the country, many hundreds of thousands of square miles; that they must be complete, accounting for everything ever mentioned. As a result much is found in our volumes that describes things that do not exist, are very rare or have only historical interest for the technically trained. I am pleading for those who want to *know* the plants that relate themselves to their professional work, to their mental life or to their recreations. Please note I said know the *plants*, not know *plant names*. No one wishes to know names apart from the plants in which he is interested. Knowing the plant is first, and then a name becomes indispensable.

And why not a name instead of a manufactured phrase palmed off as an English name? In what respect is "purple-stemmed swamp beggar ticks" better than the name? We use geranium, magnolia, forsythia, and scores of others. Why not phlox, mertensia, chrysopsis or practically any other generic name? It is true this only designates the genus, but this is all that many who are intensely interested in the plants care to know, as exemplified by our use of the words clematis, chrysanthemum, lupines and roses. Those who wish to designate the species can do so with more celerity and certainty by saying *Phlox glabrata* than by smooth-leaved sweet william. In my recent "Spring Flora" I proposed this use of the generic name seriously and I wish to assert that I have seen no reason for changing my opinion.

In closing let me express the belief that we are on the eve of a new era. Already the pendulum is swinging back. The dismemberment of genera and the multiplications of species proceed more cautiously. New species will continue to be found even in this country (hundreds of them). These ought to be and will be published. So long as work is done errors must occur, but the percentage of error, let us hope, will be greatly reduced, while the disturbing effect will be minimized by more and more of constructive work of the compendium type.

AVEN NELSON
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ON AN EXPERIMENTAL DETERMINATION OF THE EARTH'S ELASTIC PROPERTIES

It is well known that the ocean tides are caused by the differences in the attraction of the sun and moon for the surface and center of the earth. These differential forces are very small compared with the attraction of the earth for bodies on its surface; in round numbers the joint tidal force of the sun and moon on a body at the earth's surface under the most favorable circumstances amounts to only about 1/10,000,000 of the weight of the body. This force would deflect the bob of a plumb line 10 feet long from its normal position only about 1/100,000 of an inch. This deviation corresponds to an angle of only .02", or the angle which the head of a pin would subtend at a distance of 10 miles.

If the earth were a perfectly fluid mass, *i. e.*, if it offered no resistance, either elastic or viscous, to changes of shape, the surface would be tilted by the tidal forces through this same angle, and the new horizontal would be perpendicular to the new vertical. There would therefore be no change of the plumb-line relative to the earth's surface, and we could not detect the so-called "deflection of the vertical."

If the earth were perfectly rigid the plumb line would move back and forth, as the positions of the sun and moon vary, by an amount which can be calculated with an accuracy which is limited only by our knowledge of the masses and relative positions of the sun, earth and moon. As a matter of fact, the earth is partially and not entirely rigid, and therefore the excursions of the plumb line are a certain

fractional part of the full computed value. After this fraction has been found by experiment, it is possible to compute the rigidity of the earth.

In 1879 George and Horace Darwin, at Cambridge, England, attempted to measure the rigidity of the earth. They used a heavy pendulum whose motions were greatly magnified by suspending a small mirror by two fibers very close together, one of which was fastened to the pendulum bob, and the other to a rigid support. However, even with this extremely sensitive apparatus they were unable to separate any movements due to the moon's attraction from the multitude of disturbing displacements caused by changes of temperature, earth tremors, etc.

Of these disturbing elements, a very serious one is the distortion of the land caused by the immense weight of water periodically thrown upon the coasts in the ocean tides. As late as 1898 Sir George Darwin said that he doubted if it would ever be possible to isolate the effects of the tidal forces from the multitudinous disturbances of a more or less accidental character, although he recognized a possibility in the work of Paschwitz and his successor Ehlert, at Strassburg. They had already secured encouraging results by the use of the horizontal pendulum, which is in effect an exceedingly sensitive adaptation of the plumb line.

Since then measurements of this sort have been carried out by von Rebeur, Kortazzi, Hecker, Orloff and others. The experimental results are so obscured by accidental disturbances, however, that their interpretation is difficult, and the results of these various observers differ widely.

In recent years Professor T. C. Chamberlin has been much interested in the possible effect of the earth tides on the ocean tides, and he and Professor F. R. Moulton have for years been anxious to secure some definite data on the plasticity of the earth, on account of its vital bearing on questions of planetary evolution. It was through them that Professor Michelson became interested in the problem of measuring the elastic properties of the earth and designed the experiments which were conducted last autumn on the grounds of the Yerkes Observatory, at Williams Bay, Wisconsin. These experiments are described in full, with graphs and tables of observations, in the *Journal of Geology* and in the *Astrophysical Journal*, for March, 1914.

Professor Michelson's idea was to substitute a long horizontal water surface for a long pendulum, and measure the changes of level at its ends. There are many advantages in this arrangement. The length may be increased to any desired extent. The water column may be entirely under ground and thus, to a very large extent, freed from temperature disturbances. Earth tremors produce but little if any effect.

The arrangement actually used was as follows. An iron pipe, 500 feet long and 6 inches in diameter, was buried in a trench 6 feet deep along an accurately determined east and west line. At each end there was a pit 10 feet deep and 8 feet square, walled with concrete. The pipe was leveled, certainly to within one half inch, and probably to within one quarter of an inch, and half filled with water. A gauge at each end was connected at the top to the air space in the pipe, and at the bottom to the water. A needle point in each gauge was brought up from below until it nearly touched the surface of the water. The needle point was illuminated through a window in one side of the gauge by a small electric flash light. The under surface of the water formed a very perfect mirror, and the distance between the pointer and its totally reflected image was read, through a second window, with a micrometer microscope. Gauges, pipe and windows were all air-tight, so that fluctuations in barometric height at the ends were without effect. If the gauge at one end was open, the image at the other was not steady, but when both ends were closed, the reflected image was as steady and sharp as the pointer itself. Microscopes were used for which a millimeter at the focus corresponded to about 17 revolutions of the micrometer head. Observations were taken by measuring the distance between the pointer and its image at one end of the pipe,

and subtracting the corresponding difference at the other end. As the water moved, *e. g.*, toward the east end of the pipe, in response to the tidal forces, the difference (E) at the east end increased, since the water was rising higher above the pointer, and the difference (W) at the west end diminished as the water fell there. The difference $E-W$ therefore increased from hour to hour. When the water moved toward the west end of the pipe, the difference (E) decreased and (W) increased, and $E-W$ diminished. The values of $E-W$ plotted as ordinates against the time as abscissas, gave curves which represented the observed tides. Since the water moved down at one end and up at the other, and since the reflected images moved twice as far as the water surfaces, a fourfold magnification was secured. Moreover, since any change in level which might be caused by small changes in temperature or leaking altered the level at both ends alike, the errors caused by such disturbances disappeared in the double difference $E-W$. Changes in level due to the settling of the pipe between the ends were also without effect. If, however, one end settled more than the other, the double difference would increase or decrease, depending on whether the east or west end settled more rapidly, and the whole curve would be given an upward or downward slope. A similar effect would also occur if there were an appreciable change in the slope of the rock strata. But since such changes were not periodic, they would not affect the result seriously.

About eighteen or twenty readings per day, at intervals of from one to three or four hours, were taken during August, and it became evident that the method was capable of yielding very accurate results. A similar line was therefore installed in a N.-S. direction. During October and November readings were taken by the writer on both the N.-S. and E.-W. lines, with the assistance of Mr. Harold Alden, of the Yerkes Observatory staff. Readings were taken once an hour from 6 A.M. to 12 P.M. and once in two hours from 12 P.M. to 6 A.M. About four minutes usually elapsed between readings at one end of a line and the other. The mean time of the two was taken as the time of the observation. The result was the same as if the two ends had been read simultaneously at the mean time. The observations began at 8 A.M., September 27, and ended at 2 P.M., November 29, 1913.

The curves representing the tides in both the E.-W. and N.-S. pipes were very satisfactory. They showed with great faithfulness tides of the expected form, including the diurnal inequality, and spring and neap tides. The actual change of level at each end at spring tide amounted to about 0.001 inch.

But securing these observations was not all of the problem. It was necessary to know what the tides in the pipes would have been if the earth were absolutely rigid. Computations to determine them were made by Mr. W. L. Hart under the direction of Professor F. R. Moulton. The tidal forces acting on the water in the pipes depend on the positions of the sun and moon relative to the observer. These positions change in a very complicated manner. In the first place, the moon rises in the east and travels westward across the sky because of the earth's rotation. The moon has a motion eastward among the stars, completing a revolution around the earth in a month. Besides this eastward motion, it makes each month an excursion from 28° (at the present time) north of the celestial equator to 28° south of the celestial equator. Its distance from the earth varies by about 10 per cent. during the month, and its eastward motion among the stars is far from being uniform. In addition to all these things the attraction of the sun on the moon causes its motion to be more irregular than it would otherwise be, and it never moves around the earth twice in the same orbit. When all of these complex changes are properly compounded with the almost equally complex ones coming from the sun, the variations in the actual tidal forces are obtained.

Fortunately the Ephemeris gives us the positions and distances of the moon and sun for every hour, thus saving an enormous amount of computation. Even with this aid the work of computing the tides in the pipes

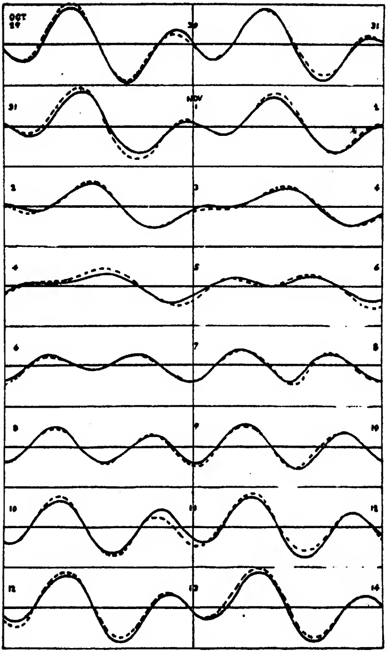

FIG. 1. E.-W. Dotted curve, observed values; full curve, 0.7 of calculated.

was very great. As the experiment progressed and the order of accuracy in the observations was seen to be high, it became necessary to increase the rigor of the computations. It was found necessary, for example, to take account of the fact that the tidal force of the moon is greater on the side of the earth next to the moon than on the opposite side. This

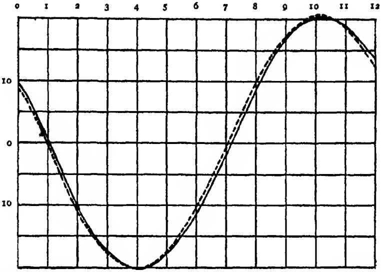

FIG. 2. E.-W. Mean of all observations, semi-daily lunar tide. Dotted curve, observed values; full curve, 0.7 of calculated.

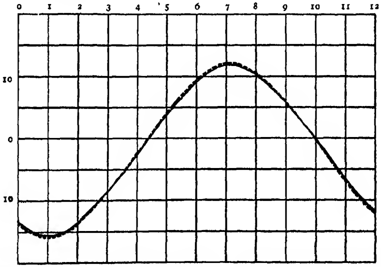

FIG. 3. N.-S. Mean of all observations, semi-daily lunar tide. Dotted curve, observed values; full curve, 0.5 of calculated.

refinement has not heretofore been necessary in work on the tides, but it introduces differences of as much as 8 per cent. In its final form Professor Moulton's formula, including harmonics of the third order, took account of all factors which affected the result by as much as 1 per cent., the probable accuracy of the experimental work.

In comparing the observed and computed tides in the E.-W. pipe, Professor Michelson found that if the computed tides were multiplied by the factor 7/10 they agreed almost

perfectly with the observed ones But the computed tides for the N-S pipe had to be reduced to about one half of the computed values to give the best agreement with the observations Sample curves for the E-W line are given in Fig 1, and the final mean values of the semi daily lunar tide for both lines are given in Figs 2 and 3 The values of the ratios finally adopted were

E-W	0 710
N-S	0 523

These figures mean that the water tide in the E-W pipe was only 71 per cent of what it would have been if the earth were perfectly rigid, *i e*, there is an E-W tide in the solid earth which is 290/710 as large as the water tide In a N-S direction there is an earth tide 477/523 as great as the water tide That is the earth yields more readily to distorting forces in the N-S direction than in the E-W direction Twice each day the surface of the solid earth rises and falls about a foot.

This result is rather surprising as there appears to be no simple reason why the earth should be more rigid in an E-W than in an N-S direction. The result was, however, foreshadowed by Schweydar in discussing the observations of Hecker at Potsdam A. E H Love has suggested that the effect may be due to the distortion caused by the weight of the ocean tides against the edges of the continents

The times of high tides along the seacoasts with reference to the moon's position are of course very irregular but if these enormous masses of water were flung against the coasts at the time they were due to rise in obedience to the moon's attraction, there can be little doubt that the effect would be to reduce appreciably the east and west earth tides, and thus to increase the apparent rigidity of the earth in this direction. But the ocean tides are so very complex that there appears to be little prospect of making accurate calculations on this point at present

Added significance is given to the possibility that the ocean tides are responsible for the difference between the E-W and N-S rigidity by a consideration of the daily, instead of the semi daily, tide In reducing the observations Professor Michelson found that if he considered the tide of period 25 812 hours, instead of the semi-daily tide, the ratios of observed to computed amplitudes were

E-W	0 72
N-S	0 66

The agreement here is much better than for the semi daily tides, but as Professor Michelson has said if the Love-Schweydar theory is correct, we would have expected a considerable increase in the E-W ratio, when the disturbing effect of the ocean tides was eliminated

Of no less importance than the ratio of the observed to the computed amplitudes is the question of their agreement in phase It was found that the maxima and minima of the observed and computed tides occurred almost exactly simultaneously The difference in phase furnishes a measure of the plasticity or viscosity of the earth If there is no difference in phase between the observed and computed tides the distortion of the earth does not lag behind the tidal forces, *i e* for any given value of the force the distortion does not tend to increase with the time If there were a lag in the earth tide it would throw the observed water tides ahead of the computed ones This is rendered obvious at once by an appropriate graph. In the reduction of the observations, Professor Michelson found that the N-S tides were behind the computed ones in the mean by about 24 seconds This lag could have no physical meaning and the amount is well within the limits of observational error In the E-W pipe the reduction shows an acceleration of 3 6 minutes This may be a real acceleration, but the quantity is not far from the limit of accuracy of the observations, and it is too small to be regarded as highly accurate

The agreement of phase between the observed and computed waves is of great importance for the theories of planetary evolution Darwin's theory of planetary fission, *i e*, the breaking off of the moon from the earth and its subsequent withdrawal to its present distance, is based on the assumption

that tides exist in the solid masses, which are of a viscous and not an elastic character. If tides are raised in a viscous body the protuberances are carried past the line joining the centers of the bodies and the differential pull on the protuberances acts as a brake on the motions of the system. The resulting effect is to slow down the rate of rotation and increase the distance between the two bodies. The tidal theory of the evolution of the moon depends chiefly on the assumption that such tides exist in the earth. The results of this experiment show that the earth-moon system has not undergone the evolution supposed by Darwin unless the interior conditions were formerly vastly different from what they are at present.

Professor Moulton's calculations show that if the ratio of the observed to the calculated tides is taken as 0.70 and the acceleration of phase as the mean of the E.–W. and N.–S., *i. e.*, 1.8 minutes, the mean rigidity of the earth is about 8.6×10^{11}, and the viscosity is 10.9×10^{16}, in C.G.S. units. These are of the order of magnitude of the rigidity and viscosity of steel. These calculations assume that the distortion decreases in geometrical progression as the time increases in arithmetical progression, and that the substance of the earth is homogeneous, a condition which does not, of course, exist. We may say, however, that the earth tides are approximately what they would be if the earth, through and through, had the properties of ordinary steel.

It would be a matter of very great interest to have similar series of observations taken at various places on the earth. Professor Chamberlin is very hopeful that the whole problem of ocean tides, now so intricate and apparently insolvable, may yield to investigations conducted along lines which take account of the joint action of the water tide and body tide. There can be no doubt, as he has pointed out, that the tides in many places are largely influenced by the rocking of the basins. It would be necessary to conduct a number of investigations like the one herein described in different regions to give definite knowledge of the facts as to the amount of the body tide, together with an ample series of inspections of the basins of the great water bodies. Professor Chamberlin also believes that we should have further investigations of this kind on account of their bearing on vulcanism and seismic disturbances. These phenomena are almost certainly connected with the elastic state and degree of rigidity of the earth-body and of its different parts.

It is Professor Michelson's intention to install an automatic recording device, and to continue the observations at Yerkes Observatory by interference methods. A considerably higher degree of precision is expected.

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EDUARD SUESS

EDUARD SUESS, dean of modern geology and geologists, passed away on April 26, 1914, in the fullness of his eighty-three years, revered by all students of his chosen earth science and loved by all who came under the influence of his warm personality.

The son of a German merchant of Jewish extraction, Suess was born in London on August 20, 1831. Here his parents resided until 1834, when they removed to Prague, and eleven years later to Vienna, where the youth was destined to rise to great eminence in the university, in the council of the city, and in the Austrian parliament. Suess was born and lived in an environment that made of him a great linguist, and during a period of his life it is said that he acquired a new language each year. Certain it is that he was at home in many tongues; and more than once, on receiving one of his characteristic letters, has the writer noted the ease with which he expressed his thoughts in English.

While in the Polytechnic School, it became apparent that Suess's natural bent was wholly toward natural history studies, and at nineteen years of age he published his first paper, a short sketch of the geology of Carlsbad and its mineral waters. In 1851 he was appointed as assistant in the geological department of the Royal Natural History Museum at Vienna, where for the next eleven years he devoted

himself to paleontology, and chiefly to brachiopods of the Paleozoic and Mesozoic eras. The comprehensiveness of his mind evinced itself even in these early years, for in 1859 and 1860 appeared a little book of 122 pages, entitled "Die Wohnsitze der Brachiopoden," in which he examines the living species, seventy-six in number, and from this draws certain conclusions as to the probable habitats of the fossil forms.

At the age of twenty-four he married the daughter of Dr. Strauss, a distinguished physician in Prague, and, as has been said by Geikie, "entered on a life of great domestic happiness, which largely contributed to the success of a strenuous career wherein science and politics came to be strangely blended."

Geikie says further:

> From his youthful days, when he described the Carlsbad springs, he had been interested in underground waters, and among the inquiries which he pursued while attached to the museum was one that embraced the relations of the soil and water supply of Vienna to the life of its inhabitants. In 1862 he published a small volume on this subject, in which he gave a comprehensive account of the economic geology of the district. At that time the city was suffering from an impure water supply and consequent typhoid fever. The luminous essay of the young professor at once attracted attention. He was the same year elected into the town council, that he might give the benefit of his advice in the steps to be taken towards the attainment of better sanitary arrangements. He boldly advocated a scheme for bringing the abundant pure water of the Alps into Vienna by means of an aqueduct 110 kilometers in length. This project, eventually adopted, was brought to a successful termination in 1873. So grateful were his fellow-citizens for the signal service thus conferred on them that they bestowed on him their highest civic distinction by electing him an honorary burgess. By this time he had made his mark in the town council as one of its most useful and able members, so that it was not surprising that he should have been chosen as one of the parliamentary representatives. For more than thirty years he sat in the Austrian parliament as a powerful leader of the Liberal party, only retiring in 1896, when advancing age made the strain of the two-fold life as a politician and man of science too great to be longer borne.

As a geologist and a member of parliament, it was natural for Suess to be deeply interested in the future supply of the monetary metals, gold and silver. He writes:

> Some years after the introduction of the gold standard in Germany, I published, in 1877, a small work, "Die Zukunft des Goldes," wherein I tried to show that from geologic indications we must expect in the future a scarcity of gold and an abundance of silver, and that the extension of the gold standard to all civilized states is impossible.

In 1892 he published his "Die Zukunft des Silbers," and this work was so well thought of that an English translation was ordered and with the author's consent was published in 1893 by the finance committee of the United States Senate. At that time his predictions were being verified; gold was becoming scarcer, and silver kept on increasing in quantity in spite of its falling price. He says:

> Under these circumstances many of my friends and myself were of the opinion that Austria-Hungary, in order to guard herself against all contingencies, ought indeed gradually to acquire a moderate amount of gold, but ought neither to proclaim a gold standard nor establish a definitive ratio between the silver florin and the gold coin

At the age of twenty-six, Suess was appointed professor extraordinary and in 1867 was promoted to full professorship in the University of Vienna, and for forty-four years he remained a great and enthusiastic teacher, retiring with the title emeritus at the age of seventy. Among his students may be mentioned Neumayr, Mojsisovics, Fuchs, Waagen and Penck.

The greater part of Suess's long life was devoted to working out the evolution of the features of the earth's surface. The problem of mountain-building presented itself to his mind during his many excursions in the eastern Alps, and in 1875 he stated his views thereon in the small volume called "Die Entstehung der Alpen," an octavo of 168 pages. Up to this time his publications numbered sixty titles, his studies having ranged over nearly all the branches of geology.

"Die Entstehung der Alpen," to quote again from Geikie,

contains the germ of those later contributions to science which have placed him on so conspicuous an eminence among the geologists of the day It sketches the general principles of mountain architecture, especially revealed by a study of the Alpine chain. But he did not confine his view to the particular area with which he was himself personally familiar Already his eye looked out on the wider effects of the unequal contraction of the terrestrial crust, and swept across the European continent eastward into Asia, and westward across the Atlantic into America. To thoughtful students of the science this treatise in his firm hold of detail combined with singularly vivid powers of generalization, was full of suggestiveness But the interest and importance of its subject did not obtain general recognition until it was followed ten years afterwards (1885) by the first volume of the great "Antlitz der Erde'—the work which has chiefly given Suess his place among his contemporaries, and by which his name will be handed down to future time In its striking arrangement of subjects, in its masterly grouping of details which notwithstanding their almost bewildering multiplicity are all linked with each other in leading to broad and impressive conclusions and in the measured cadence of its finer passages the "Antlitz may be regarded as a noble philosophical poem in which the story of the continents and the oceans is told by a seer gifted with rare powers of insight into the past

The writer had the great pleasure of meeting Suess during the Ninth International Geological Congress held at Vienna in August 1903 Tall and powerful decisive and yet kind his great head covered by the familiar soft felt hat, the man left an indelible impress upon my memory during the hour in which we talked of paleogeography seas and barriers To me the personal interview was memorable but the great mental power and vivid imagination of the master mind naturally showed to better advantage at the farewell banquet given by the congress at the Hotel Continental on the evening of August 27 Tietze presiding as president of the congress gave the official farewell in French Following him, and speaking in his own tongue, came Geikie, telling of his first visit to Vienna forty years since and saying that of those he met at that time nearly all were gone excepting Suess, then a young man of great prominence, since known to all geologists through his masterly work "Das Antlitz der Erde' This reference to the time when Geikie and Suess—both of whom later became storm centers in geology—were young visibly affected the latter Toward the end of the speaking he arose and with bowed head and in a low voice which increased to greater volume as he went on, he made in German a most eloquent appeal to geologists to rise to ever greater and better work Unfortunately no one was at hand to take down what he said, and so after the dinner I asked him if he would be so kind as to put his speech in writing This he did a few days later and a translation of it appeared in the *American Geologist* for January 1904 In part this is as follows

Returning to his earth the geologist perceives that the sum total of life s phenomena not only forms a single phenomenon but that it is also limited by space and time It occurs to him now that the stone which his hammer strikes is but the nearest lying piece of the planet that the history of this stone is a fragment of the history of the planet and that the history of the planet itself is only a very small part of the history of the great, wonderful ever changing Kosmos

His heart then thrills he feels called as a co laborer on the most sublime problems in which feeble mortal beings can take part Then too he sees that the fundamental lines of structure coursing over the earth s surface have nothing to do with the political lines separating the nations The vastness of the problem itself makes the concord of civilized nations natural, and they remain separated only through their emulation all filled with the idea that mankind in general will most highly esteem that nation which s in the position to offer the most and the best of noble example of new truth and of ideal worth.

CHARLES SCHUCHERT

YALE UNIVERSITY

SCIENTIFIC NOTES AND NEWS

SURGEON GENERAL W C GORGAS has received the degree of doctor of laws from Yale University and from Princeton University

THE degree of LL.D was bestowed by the University of California on commencement day on Eugene Woldemar Hilgard, from 1874

to 1906 professor of agriculture and dean of the College of Agriculture, upon George Holmes Howison, Mills professor of intellectual and moral polity in the University of California from 1884 to 1909, and on William Mulholland, the engineer

At its recent commencement Wesleyan University conferred the degree of doctor of science on Dr Walter P Bradley who has this year retired from the professorship of chemistry which he had held since 1893

Dean Frank D Adams, of McGill University school of applied science, received the honorary degree Sc D at the Tufts College commencement. Incidentally he spoke at the annual dinner of the Association of Harvard Engineers and Dr and Mrs. Adams were the guests of the geologists of Greater Boston at a dinner at the University Club

On the occasion of the opening of the new physiological laboratory at the University of Cambridge on June 9 the degree of doctor of science was conferred on Sir William Osler, Sir David Ferrier, Sir Edward Schäfer and Professor E H Starling

The first award of the Chandler gold medal was made to Dr L H Baekeland when the Charles F Chandler lectureship at Columbia University was inaugurated by an address given by him

The Royal Society of Arts will confer the Albert medal for the current year on Chevalier Guglielmo Marconi for his services in the development and practical application of wireless telegraphy"

The Geological Society of London has elected to foreign membership Dr F J Becke, professor of mineralogy at Vienna, Dr T C Chamberlin, professor of geology in the University of Chicago, Dr F J Loewinson Lessing professor of mineralogy and geology at St. Petersburg, Dr A P Pawlow, professor of geology and paleontology at Moscow, Dr W B. Scott professor of geology in Princeton University, Dr P Choffat, Geological Survey of Portugal and Dr Charles R. Van Hise, president of the University of Wisconsin.

Director William Wallace Campbell, of Lick Observatory, has gone to Russia on the Crocker Expedition to observe the total eclipse of the sun For this purpose Regent William H Crocker gave $5,800 to the University of California.

Dr. Simon Flexner and Dr Peyton Rouse, of the Rockefeller Institute for Medical Research have gone to Spartanburg, S C, to study the situation in regard to pellagra.

Mr. J S Diller, geologist of the United States Geological Survey, has gone to Mount Lassen to prepare a report on the eruptions of the peak

On June 23 Dr Alexander G Ruthven and Mr Frederick M Gaige, of the museum of zoology of the University of Michigan, sailed for British Guiana where they will carry on zoological field studies The principal field work will be the study of the local distribution and habits of the amphibians, reptiles and ants, and the gathering of extensive collections of amphibians reptiles, ants, molluscs and crustaceans An attempt will also be made to secure specimens in a few groups other than those mentioned, particularly in those needed to fill out the synoptic collections in the museum

A party from the Peabody Museum of Yale University, under the leadership of Professor R. S Lull, is to explore the Miocene along the Niobrara River Nebraska, this summer in the hope of securing additional fossil vertebrate material to supplement the great Marsh collection at Yale

Dr. Robert K Nabours, professor of zoology in the Kansas Agricultural College and zoologist of the Kansas State Experiment Station, sailed on May 19 for Rotterdam He will visit for the college the agricultural experiment stations of Russia, Turkestan and Central Asia, making special study of the work in animal genetics and securing specimens for his experiments On the return trip he will visit experiment stations in Germany and other European countries

Dr. Charles H Ellwood, professor of sociology in the University of Missouri, has been

granted a sabbatical year's leave of absence, and will spend the larger part of his time in England studying social conditions Dr L L Bernard, professor of sociology in the University of Florida, will have charge of the work in sociology in the University of Missouri during Professor Ellwood's absence

PROFESSOR L E DICKSON, of the University of Chicago, will be visiting professor of mathematics in the University of California from August to December, 1914

DR. C H T TOWNSEND director of the entomological station at Lima Peru should after July 1 be addressed at the U S National Museum

ON June 4 a number of plant pathologists of the Pacific Coast, meeting at Davis Cal formed a Western Branch of the American Phytopathological Society The following officers were elected *President*, Ralph E Smith, Berkeley, Cal , *Vice-president* H S Jackson, Corvallis, Ore , *Secretary* W T Horne, Berkeley, Cal

AT the annual meeting of the Medical Research Club of the University of Illinois Dr Wm H Welker was elected president and Dr J J Moore, secretary for the next academic year

THE annual address before the graduating class of the School of Medicine of the University of Alabama, at Mobile, was delivered by Surgeon General William C Gorgas

DR. JOHN F ANDERSON, director of the Hygienic Laboratory, U S Public Health Service, delivered the annual address on June 9, before the Alumni Association of the College of Medicine, Syracuse University The subject of his address, which was illustrated with lantern slides, was 'The United States Public Health Service its Organization, its Work and its Accomplishments"

A MONUMENT to Captain Scott and the companions who perished with him will be unveiled during the summer at Finse, Norway The memorial will be nearly 20 feet high, and will bear the names of the explorers, with the inscription, in Norwegian, "The South Pole, January, 1913 Erected by Norwegians" The funds for the monument have been raised by a newspaper, and donations have been contributed by the Norwegian government, the Geographical Society, and a number of prominent men from all parts of the country

THE seventh centenary of the birth of Roger Bacon was commemorated at Oxford on June 10 by the unveiling of a statue in the University Museum and by the delivery of a series of addresses The statue which is the work of Mr Herbert Pinker, was unveiled by Sir Archibald Geikie and was accepted on behalf of the university by the chancellor, Lord Curzon of Kedleston It presents Bacon in the habit of a Franciscan friar holding in his hands an astrolabe with a desk in front of him It is a full length figure in white marble

DR RUPERT NORTON assistant superintendent of the Johns Hopkins Hospital died on June 19, of typhoid fever

DR JOSEPH REYNOLDS GREEN, F R S, known for his important researches in plant physiology, fellow and lecturer of Downing College, Cambridge, and formerly professor to the Pharmaceutical Society of Great Britain, died on June 3

THE U S Civil Service Commission announces an examination for metallurgical engineer for work in iron and steel, eligibles to fill a vacancy in this position in the Bureau of Mines Department of the Interior for service at Pittsburgh Pa at a salary ranging from $3 000 to $4 500 a year

THE medical school of the University of Minnesota has adopted the principle of teaching fellowships in the clinical departments, with the end in view of providing well trained full time assistants and research workers and at the same time giving a basis for graduate instruction in the various specialties It is arranged that the fellowships be in three grades, viz., first year, $500, second year, $750, third year, $1,000 To be eligible to a first year fellowship a candidate, as a general rule, must have received his M D degree from an acceptable school and have served one year as interne in a good hospital. The fellows ap-

pointed under this system will give their entire time to study, research and such assisting in clinics as they may be prepared for. A course of study will be laid out for each fellow, adapted to prepare him for the specialty chosen by him. This course will include work in the laboratory branches, dispensary service, hospital service and investigation. It is probable that the course (of two or three years?) will lead to a degree properly recognizing the specialty in which the candidate has worked. Arrangements may be made whereby these fellows can spend one year at the Mayo Clinic and count the same toward the advanced degree. In order to inaugurate the system the board of regents of the university has authorized the following teaching fellowships for the next school year: one each in medicine, in surgery, in obstetrics and gynecology and in eye, ear, nose and throat, each of $500. There is also provision for one $500 fellowship and one $1,000 fellowship in mental and nervous diseases, or in lieu of these a $1,500 instructorship.

The Geological Survey has completed its preparations for the annual campaign of investigating the mineral resources of Alaska, the field plans for the year having been approved by Secretary Lane. Eleven parties will be put in the field this year, and as in the past special heed will be given to the investigation of the resources of those districts which are tributary to the several routes that have been advocated for the proposed government railways. A party under the leadership of J. W. Bagley and Theodore Chapin will undertake the exploration of the region tributary to Talkeetna River and will connect with the surveys of the Broad Pass region made last year. An exploration of the region lying between Lake Clark on the east and the Iditarod district on the west will be undertaken by R. H. Sargent and Philip S. Smith. A. G. Maddren will investigate the goldplacer districts tributary to the lower Kuskokwim. He will ascend Iditarod River by canoe, portage across the divide to reach the Kuskokwim, and visit the Anniak, Tuluksak and Goodnews Bay placer districts. Stephen R. Capps and C. E. Giffin will carry geologic and topographic surveys across Skolai Pass into the White River basin and thence to the international boundary. A detailed base map will be made of part of the Juneau district, now the most important gold lode camp in Alaska and promising to become one of the most important on the continent. D. C. Witherspoon will undertake the making of the map, which will be on a scale of three inches to the mile. A survey of the Kotsina copper bearing area was undertaken in 1912. It is planned that F. H. Moffit and J. B. Mertie now complete this work. B. L. Johnson, with one assistant, will undertake the detailed geologic survey of the Port Valdez gold and copper district. To coordinate and correlate the various geologic surveys in Alaska it is necessary to continue the studies of the general geology and mineral resources. Three geologists will be engaged in this work during 1914. George C. Martin, assisted by R. M. Overbeck, will continue his studies of the Mesozoic stratigraphy. He will visit localities in southeastern Alaska, in the Chitina Valley and along the Yukon. H. M. Eakin will undertake supplementary investigations of the tin deposits of Alaska. Alfred H. Brooks, the geologist in charge of the Alaska surveys and investigations, expects to leave for Alaska as soon as office work permits. He will study especially the problems of Quaternary geology, including the genesis and occurrence of placer deposits. He will visit the Iditarod and Fairbanks districts and, time permitting, the Nome district. Mr. Brooks will also join the Moffit party in the Kotsina district and the Johnson party in the Valdez district for brief periods of time.

Dr. W. P. Herringham, vice-chancellor of the University of London, and Sir Alfred Pearce Gould, chairman of the Brown Institution Committee, write to the London *Times* with reference to the movement for further university research into the causation of swine fever and other animal diseases, that the work of the Brown Animal Sanatory Institution belonging to the University of London has not

been generally recognized. They say that "The Brown Institution was founded under the will of Mr Thomas Brown of Dublin who died in December, 1852 and left about £20,000 to the University of London for the purpose of 'founding an institution for investigating and . . endeavoring to cure maladies, distempers and injuries any quadrupeds or birds useful to man may be found subject to'. The institution, at 149 Wandsworth road was opened in 1871 Many of its researches have been carried out at the instance and on behalf of government departments and the diseases investigated have been numerous and diverse in character, including anthrax, actinomycosis hydrophobia (for the Hydrophobia Commission), vaccinia (for the Local Government Board), tuberculosis swine fever (for the Board of Agriculture), and sleeping sickness We may refer particularly to the research on Johne's disease of cattle by Mr F W Twort the present superintendent of the institution and Mr G L Y Ingram, who succeeded in growing outside the animal body the causative bacillus of the disease The work had to be curtailed owing to the fact that the institution was unable to provide the funds necessary for the keep of infected animals for experimental purposes We are thoroughly in agreement with the Berks and Oxon Chamber of Agriculture that such investigatons are best carried out in a place like a university We beg further to point out that in the Brown Institution the University of London has the nucleus of exactly such a research department as is required, and that nothing but adequate funds are needed for its further development."

UNIVERSITY AND EDUCATIONAL NEWS

AT the celebration of the centenary of the foundation of the Yale University Medical School, large gifts were announced in addition to the $500,000 from the General Education Board. These included a provisional gift of $500,000 for the Anthony N Brady foundation and $600,000 from donors not officially named.

BY the will of James Campbell, the St Louis University Medical School will receive his entire estate after the death of his heirs, who have a life interest in it. The present value of his estate is estimated to be from $15,000,000 to $40,000,000

BY the will of Thomas W Holmes, of Troy, Rensselaer Polytechnic Institute is bequeathed the sum of $50 000

BY the will of the late Dr Joseph D Bryant, professor of surgery in the University and Bellevue Hospital Medical College, a trust fund of $1 000 is established for the benefit of New York University The directions regarding it left by Dr Bryant were as follows

The income of this fund shall be devoted to instilling in the minds of the senior class the principles of ethics of the American Medical Association" Upon the death or remarriage of his widow one seventh of Dr Bryant's residuary estate is to be given in trust to New York University, and one seventh in trust to the New York Academy of Medicine One contingent bequest of $10,000 is to be devoted to opposing the efforts of anti vivisectionists in New York State

MISS SUSAN MINNS has given $50,000 to the department of botany of Wellesley College, in memory of Susan M. Hallowell, the former head of the department.

SIR GEORGE KENDRICK has given $90,000 to the University of Birmingham to endow the chair of physics in memory of the late Professor John Henry Poynting

THE trustees of Columbia University have appointed Dr Warfield T Longcope, to be Bard professor of the practise of medicine to succeed Dr Theodore C Janeway, who goes to the Johns Hopkins University Professor Longcope is also nominated medical director of the Presbyterian Hospital. The department of therapeutics has been merged with that of clinical medicine and Dean Samuel W. Lambert, formerly professor of therapeutics, has been appointed professor of clinical medicine Dr Charles C Lieb has been appointed assistant professor of a new department of

pharmacology and Dr. William Darrach has been appointed assistant professor of surgery.

Dr. Ross A. Gortner, since 1909 resident investigator in biological chemistry at the station for experimental evolution of the Carnegie Institution of Washington, has been appointed associate professor of soil chemistry in the University of Minnesota.

Dr. Karl F. Meyer, whose special field is the tropical diseases, has been promoted to be professor of bacteriology and protozoology in the University of California.

Dr. J. Howard Agnew, formerly first assistant in the department of medicine, University of Michigan, has accepted the full time professorship in medicine in the University of Alabama, School of Medicine, at Mobile.

At Dartmouth College Drs. E. J. Rowe and E. S. Allen have resigned as instructors in mathematics, the latter to accept an instructorship at Brown University. Dr. R. D. Beetle, of Princeton University, and Dr. L. C. Mathewson, of the University of Illinois, have been appointed instructors in mathematics.

D. K. Picken, professor of mathematics in Victoria College, University of New Zealand, has been appointed master of Ormond College, Melbourne University.

DISCUSSION AND CORRESPONDENCE

DADOURIAN'S ANALYTICAL MECHANICS

In the issue of Science of April 3, Dr. Dadourian replies to my criticism of his "Analytical Mechanics." His reply was read with interest. It was hoped that he would clear up several points in this reply that seemed to the reviewer as unsatisfactory. I do not wish to get into a controversy, but it seems to me that his standpoint is untenable. He says in his reply:

> It is a fact that I have applied vector addition to forces *without hesitation*, but I have shown as little hesitation in treating velocities, accelerations, torques, linear momenta and angular momenta as vectors. Why did not Professor Rettger accuse me of having assumed the "parallelograms" of these magnitudes? Is the "parallelogram of forces" more of a dynamical law than the parallelogram of torques, for instance? The parallelogram law applies to any vector and is not at all a characteristic of forces, therefore it is not a dynamical law. It does not even deserve being called a "law" when applied to a special type of vectors. In its most general form the "parallelogram law" is the principle of the independence of mutually perpendicular directions in space, a purely geometrical principle. ... After devoting an entire chapter to vector addition and after defining force as a vector to introduce the "parallelogram of forces" as a new law, as Professor Rettger would have it, could serve only to show that the man who did it could not have a clear conception of the meanings of the terms he was using.

Let us assume that a body originally in the position O moves first through a distance, a, in a given direction and then through a distance b in another direction. Assume the body finally to be in the position C. The resultant displacement then is $OC = c$. The body would be in the same position, C, if it had moved first through the distance b and then through the distance, a; that is its final position or its final displacement is independent of the order in which the two displacements take place. They may take place, therefore, simultaneously and the final or resultant displacement is still equal to c. If then we recognize that the two displacements have no mutual effect on each other, or what amounts to the same thing, that the displacements are independent of each other, then the resultant displacement may be represented by the diagonal of a parallelogram of which the two displacements are adjacent sides. As soon as this "Principle of Independence" is once recognized, then the "parallelogram law" can be proved to hold also for velocities, accelerations and other conceptions of kinematics. The parallelogram law as applied to these quantities is then equivalent to the "principle of the independence of motions" and as such is a purely "geometric principle." These quantities, displacements, velocities and accelerations are therefore vectors in accordance with the definitions of a vector, and the principles of vector analysis may be applied advantageously.

Vector analysis may be called an algebra that rests on certain (arbitrary) assumptions, and the "parallelogram of vectors" is one of

these fundamental assumptions. To define a quantity as a vector, and then conclude that the parallelogram law holds begs the whole question. The logical way to proceed would be to first *prove* that the quantity is a vector, that is, that the parallelogram law holds and then (advantageously) apply the principles of vector analysis. We can not prove, however, that a *force* is a vector. We must depend upon experience for our justification in assuming a force to be a vector.

We do not know what a force is. To say that "force is an action" explains nothing, and to define it as a vector begs the whole question. Experience and experience alone can justify us in dealing with forces as vectors of a certain kind. In other words, the "parallelogram law of forces" is nothing more than an assumption and is *not* a purely "geometric principle." If we *assume* that a force can be measured by the motion it produces, and if we *assume* that the effect of each force is independent of the effect of the other forces acting, then it follows that the parallelogram law holds also for forces, since we know that this law, as a consequence of the principle of independence, does hold for the motions (accelerations) produced. This argument, however, makes two assumptions. First, it assumes that a force can be measured by the acceleration it produces (in its own line of action), and, secondly, it assumes "the principle of independence" for forces. Now these two assumptions are involved in Newton's Second Law of Motion. In other words, the parallelogram law of forces is a consequence of Newton's Second Law of Motion, and, therefore, in its last analysis is an assumption. If, however, the parallelogram law is once assumed for forces, then it can be proved for moments and other (vector) qualities involving force. It is, therefore, sufficient to *assume* the law to hold for *forces*.

It is a question whether we have a right to assume the parallelogram law even for velocities and accelerations without proving it, and to assume it for forces is equivalent, as we have seen, to assuming Newton's Second Law of Motion.

In my criticism it was stated:

> On page 102 he assumes that a force is proportional to the accelerations produced. This assumes Newton's Second Law.

In reply he says:

> This statement is not quite right. The relation between force and acceleration which I have called *force-equation* is derived on page 106 from the fundamental principle which I have postulated. In this derivation I have made use of the definition of kinetic reaction which is stated and illustrated on pages 102 to 105, but this is not equivalent to assuming a new principle.

This is true as far as it goes, but he fails to add that the form of this "force-equation" depends upon the actual value of this "kinetic reaction" which he finds as the result of experiments to be equal to the mass times the acceleration produced, that is,

$$\text{Kinetic reaction} = mf.$$

He seems to me to be making a "distinction without a difference." At least he is making an assumption here that is equivalent to assuming Newton's Second Law of Motion.

E. W. RETTGER

CORNELL UNIVERSITY

ACCESSORY CHROMOSOMES OF MAN

IN reply to Professor T. H. Morgan's statement in SCIENCE, June 5, 1914, I wish merely to request the reader who may be interested to read my note of May 15[1] and my paper, "Accessory Chromosomes in Man,"[2] and then Professor Montgomery's paper,[3] that he may decide for himself whether Montgomery and I have not agreed in the main regarding the accessory chromosomes of man. This was the only point at issue in my former communication, which was meant not as a "complaint," but as a correction to a misleading inference.

As to the material on which Montgomery and I came to different conclusions regarding a second pairing of the ordinary chromosomes, Professor Morgan is mistaken in stating that

1 SCIENCE.

2 *Biol. Bull.*, XIX., 4; September, 1910.

3 *Jour. Acad. Nat. Sci. Phila.*, XV., second series, 1912.

we obtained our results from "the same identical preparations." Montgomery never saw my preparations, nor I his. For a minor part of his work he used some material from the same individual I had worked on, but this material had been standing in alcohol some two years before he obtained it from me, so that it is to be expected that he would not get as clear-cut preparations as from freshly fixed material, to say nothing of the fact that fixation may have been unequal in different bits of the tissue.

Concerning the question of sex chromosomes in fowls, I may say that in my opinion the final word has by no means yet been said. I hope in the near future to contribute some further evidence in the matter.

M. F. GUYER

SCIENTIFIC BOOKS

Chemistry in America. Chapters from the History of the Science in the United States. By EDGAR F. SMITH, Blanchard Professor of Chemistry, University of Pennsylvania. Illustrated. New York and London, D Appleton and Company. 1914. Pp. xiii + 354. Price $2.50.

In his preface the author says: "The writer has lectured for several years to his graduate students on the development of chemistry in the United States. A mass of material has been collected, most of which is not only interesting but valuable. Repeated requests have been made for the publication of these facts as a history of chemistry in the United States. To the writer's mind the information in his possession is not sufficiently complete to warrant such an important undertaking. The earliest endeavors of our country's scientists require even more careful and extended research."

The earliest contribution to chemistry from this country appeared September 10, 1767, in the *Transactions of the American Philosophical Society.* The title is "An Analysis of the Chalybeate Waters of Bristol in Pennsylvania." The author is Dr. John de Normandie. Liberal quotations from the article are given which show that the author used the balance. Then follow quotations from an article by James Madison, who was professor of chemistry and natural philosophy at William and Mary College as early as 1774, and from an article by Dr. Robert McCauslin. The author of the book thereupon remarks: "These communications testify to a spirit of inquiry, at least, on the part of our early devotees to science. They are, further, interesting in that they show the use of the balance as early as 1768 and indicate the steps of analysis."

In 1792 the Chemical Society of Philadelphia was founded by James Woodhouse. The fact is noted that the members of this society favored Lavoisier's doctrine of combustion.

According to Dr. Smith "the arrival of Joseph Priestley in America in 1794, and his frequent presence among the men of science of that day, greatly stimulated scientific studies." But Priestley's thoughts appear to have been on theological subjects fully as much as on scientific in these latter years of his life. He was elected professor of chemistry in the University of Pennsylvania in 1794 but felt obliged to decline the honor. In a letter to Dr. Rush in regard to this he says: "Nothing could have been so pleasing to me as the employment, and I should have been happy in your society, and that of other friends in the capital, and, what I have much at heart, I should have an opportunity of forming an Unitarian congregation in Philadelphia."

Thomas Cooper, professor at Dickinson College and afterwards at the University of Pennsylvania, was the first one to make metallic potassium in this country. He was also the editor of Thomas Thomson's "System of Chemistry." From 1820 to 1834 he was president of the College of South Carolina, "attaining distinction as an extreme advocate of the States' Rights doctrine during the nullification period."

Robert Hare, who was born in Philadelphia in 1781, was without doubt the most influential chemist of his time in America. In 1801, when he was only 20 years old, he communicated to the Chemical Society of Philadelphia a description of the oxy-hydrogen blowpipe which

afterwards came to be known as the compound blowpipe. The communication is entitled "Memoir of the Supply and Application of the Blow-pipe, Containing an Account of the New Method of Supplying the Blow-pipe either with Common Air or Oxygen Gas; and also of the Effects of the Intense Heat Produced by the Combustion of the Hydrogen and Oxygen Gases." Of this Dr. Smith justly remarks, "It is a real landmark in scientific discovery."

Hare later became professor in the University of Pennsylvania which position he held until his resignation in 1847.

Due reference is made to Benjamin Silliman, John P. Norton, Evan Pugh, Robert E. Rogers and Theodore Wormley. James C. Booth is spoken of as probably the first American to study analytical chemistry in Germany. "With an education probably unequalled at that time by any chemist in America, he returned to the United States, and, in 1836, established in Philadelphia a laboratory for instruction in chemical analysis and applied chemistry."

Of T. Sterry Hunt (1826–1892) the author speaks as "an active participant in the upbuilding of chemistry in America." J. Lawrence Smith (1818–1883) was active about the same time. His paper on a method of analyzing silicates by the use of calcium carbonate and chloride "was a very valuable contribution to analytical methods."

Frederick A. Genth (1820–1893) was a German by birth. He came to this country in 1848. After "conducting a laboratory for commercial analysis and the instruction of special students in chemistry, he became professor of chemistry in the University of Pennsylvania in 1872.

"His earliest contributions were upon geological subjects. Later he devoted much time to mineralogical problems. The chemical research by which he is best known relates to the ammonia cobalt bases (the cobaltamines) developed jointly with Wolcott Gibbs. His original memoir was published in 1851 and contained the first distinct recognition of the existence of perfectly well defined and crystallized salts of the ammonia cobalt bases. The joint monograph of Genth and Gibbs appeared in 1856. This elaborate and extended research has always stood among the finest chemical investigations ever made in this country."

"Wolcott Gibbs (1822–1908) for years held the most commanding position among the chemists of the United States."

"It was Gibbs's peculiar merit, that he, more than any other man, introduced into the United States the German conception of research as a means of chemical instruction."

His investigations covered a wide range of subjects in organic, analytical, organic and physical chemistry. "It was in the great research upon the ammonia cobalt bases, to which reference has already been made, that Gibbs finally found himself."

His most important contribution to analytical chemistry was the electrolytic determination of copper now universally used. "The entire field of electro-analysis was thus thrown open by him." His remarkable series of researches upon the complex inorganic acids, the publication of which began in 1877, continued well into the 'nineties.

Gibbs undoubtedly exerted a powerful influence upon the development of chemistry in this country. His sympathy with young men, his enthusiasm, his absolute fidelity to the highest ideals deeply affected many a young worker and helped to hold him on a true course.

Others whose work is discussed in the book before us are Albert Benjamin Prescott, Samuel W. Johnson (1830–1909), a pioneer in agricultural chemistry, John W. Mallet (1832–1912) of the University of Virginia, M. Carey Lea (1823–1907) and Josiah Parsons Cooke (1827–1894) of Harvard.

The book closes with some account of J. Willard Gibbs (1839–1903) of Yale, whose contributions to physical chemistry "are fundamental in nature and of broad application."

Dr. Smith has wisely refrained from speaking of those who are still alive. In conclusion he says: "It is not the writer's purpose to discuss the investigations which have come from the many working centers of the United

States during recent years, that story awaits another narrator; but, if only a desire, on the part of Americans to learn more concerning the place which American chemists occupy in the world's history of chemistry, is awakened, this compilation of facts will not only have been a pleasure but it will have served a worthy purpose."

The book is to be regarded as a "compilation" and not as a history. All American chemists should be thankful to the author for the pains he has taken to collect this material and for placing it before us. It furnishes the basis for the history of chemistry in America which remains to be written.

It is interesting to note the fact that so many of those who are necessarily mentioned in the book were connected with the University of Pennsylvania. It is, therefore, most appropriate that this work of compilation and comment should have been done by the one who at present holds the two important positions in that university of provost and professor of chemistry.

Ira Remsen

Das Relativitatsprinzip. By Lorentz, Einstein and Minkowski. Leipzig: B. G. Teubner. 1913. Pp. 89.

Under the general title Fortschritte der mathematischen Wissenschaften in Monographien, Otto Blumenthal is issuing a series of which number 2 is a collection of six papers by eminent advancers of mathematical physics dealing with relativity.

The first paper is a short note by Lorentz of date 1895 in which the hypothesis of shortening in the direction of motion is discussed, practically for the first time, though both he and FitzGerald had for some time been familiar with it. The second is a translation of Lorentz's very famous Electromagnetic phenomena in a system moving with any velocity smaller than that of light, dated 1904. Here not only the hypothesis of shortening, but the Lorentz group, fundamental in relativity theory, is found.

The third article is Einstein's epochal formulation (1905) of the principle of relativity as a fundamental physical principle independent of any hypothesis of shortening. He goes right at the heart of the matter in that direct way which has been so characteristic of his theories. The next is a short note, not two and one half pages, in which Einstein points out that a consequence of the foregoing work is the proportionality of mass and energy.

Minkowski's Raum and Zeit (1908) is the fifth article. Here the simple four-dimensional formulation of mechanics and of the inverse square law of attraction is first clearly exhibited—yet not so clearly that Sommerfeld's explanatory notes are unwelcome. This address of Minkowski's had been reprinted separately, and to the exhaustion of the edition is perhaps due the publication of the present collection.

The final article is from Lorentz's Alte und Neue Frage der Physik (1910) and forms an appropriate close to a series which presents concisely and at first hand the steps in the development from the Michelson experiment to the full fledged theory of relativity.

E. B. Wilson

Controlled Natural Selection and Value Marking. By J. C. Nottram. New York, Longmans, Green and Co. 1914. Octavo. Pp. 130.

The author of this book advances a new theory to account for the origin of sexual dimorphism and of polymorphism within animal species. He starts with the assumption that the competition in the struggle for existence is frequently between groups rather than between individuals. Thus, family may compete with family, or pair with pair, rather than individual with individual. Conspicuousness on the part of one member of the family (its least necessary member) it is supposed, may insure persistence of the family by drawing the attacks of enemies to the one and thus diverting them from the more valuable members of the family. Thus male conspicuousness, in sexually dimorphic species, is supposed to be advantageous to the female and young. "Controlled natural selection ac-

counts for both the origin and purpose of secondary sexual characters in the following way Males are more conspicuous in nature than females males are less valuable than females Males and females are associated together during life, and especially during the breeding season when the difference in color is greatest, and when their difference in value is highest therefore according to the theory the conspicuous color of the male serves to control natural selection in such a way that the less valuable male will be killed in preference to the more valuable female

It is assumed that if the male is taken the female and young will *not* be taken But the reader might reasonably inquire how the family would be benefited by the loss of its strongest member and how the survivors would be protected after his demise Is it to be supposed that the appetites of all enemies will be permanently appeased by a single meal and that the father having been taken the family will not be further molested?

Not only conspicuousness due to color but also such as may arise from movement sound or scent is interpreted in this same way This puts a new meaning on courtship and other means of display and on song which are all supposed to be protective to the family in which they occur by causing the destruction of those individuals which thus advertise themselves which result is then supposed to give the others a better chance to survive

For illustrations in support of his theory the author relies chiefly upon British birds though reference is frequently made also to insects

W E CASTLE

PUBLICATION OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC FOR 1916

THE *American Ephemeris and Nautical Almanac* for the year 1916 recently issued by the U S Naval Observatory differs materially in construction and arrangement from previous numbers of this publication.

The preparation of this volume marks the inauguration of the scheme of cooperation adopted by the congress of representatives of the various national Ephemerides held at Paris in 1911 In accordance with this agreement a portion of the material contained in the volume for 1916 including the greater part of the Greenwich Ephemerides of the moon and planets and the apparent places of the stars has been supplied by the foreign almanac offices while the office of the American Ephemeris has in turn furnished to all foreign offices the data regarding eclipses occultations physical ephemerides of the sun moon and planets etc This system of exchange reduces considerably the amount of duplication of work by different computers and will it is believed prove mutually beneficial to the offices concerned

Congress has however in the law authorizing this exchange provided that any such arrangement shall be terminable on one year's notice and that the work of the Nautical Almanac Office during the continuance of any such arrangement shall be conducted so that in case of emergency the entire portion of the work intended for the use of navigators may be computed by the force employed by that office and without any foreign cooperation whatsoever and that employees whose services in part can be spared on this account may be employed in improving the tables of the planets moon and stars to be used in preparing for publication the annual volumes

A rearrangement of the material contained in the first part of the Ephemeris has been made with the view of giving it in better and more convenient form for the astronomer Instead of giving portions of the ephemerides of the sun and moon alternately, month by month, there is now given for the entire year first the ephemeris of the sun complete, then the ephemeris of the moon complete, then the ephemeris of each of the seven major planets.

Other changes worthy of note are the following Daily ephemerides are given for 35 circumpolar stars instead of 25, and they have been arranged in more convenient form. The apparent right ascensions of stars whose declination is less than 60° are given to 0 ^{s}001, and the apparent declinations of all stars are

given to 0."01. The data relative to eclipses, occultations, physical ephemerides and satellites, are given in Greenwich time instead of Washington time. The style of type adopted permits the publication of much of the material in a more condensed form without loss of legibility.

The preparation of the material for the *American Ephemeris and Nautical Almanac* for 1917, on the same general lines as the volume for 1916, is now well advanced.

J. A. Hoogewerff

U. S. Naval Observatory

BOTANICAL NOTES

FOREST TREE DISEASES

A handy little field manual for the practical use of foresters has been prepared by E. P. Meinecke, forest pathologist, in the Bureau of Plant Industry of the United States Department of Agriculture, under the title "Forest Tree Diseases Common in California and Nevada." In less than 70 pages the author manages to call the attention of the reader to about twenty-five diseases of various parts of the tree, and to give some general notions as to the nature of disease in plants, and the structure of the fungi which cause most of the tree diseases. Twenty-four half-tone reproductions of photographs help to make it easier for the young forester to identify the particular trouble he may have in hand.

ANOTHER TREE BOOK

Appealing largely to foresters also, Professor J. H. Schaffner's "Field Manual of Trees," may well be noticed here. For the region covered (Virginia, Kentucky and Missouri northward, and westward "to the limits of the prairie") we do not know of a more useful little book than this. In about 150 pages the author makes it possible for the reader to determine the name and relationship of the native and more commonly cultivated trees of the northeastern United States. It should find a large use in the high schools of the country and the young forester will find it a most handy book to have in his pocket when he goes into the woods.

A PHARMACEUTICAL BOTANY

In a little more than one hundred pages Professor H. W. Youngken and F. E. Stewart have condensed the principal morphological and taxonomic portions of botany that they deem should be known by the student before he enters the field of pharmacology. As a hand-book to accompany a course of lectures this little book should prove very helpful, and apparently this was the purpose the authors had in mind when they prepared the text. We imagine that this booklet or one something like it might prove useful in other applications of science, as in agriculture, horticulture, agronomy, medicine, etc.

FLORA OF SOUTHEASTERN WASHINGTON

More than a dozen years ago Professors Piper and Beattie, of the State College of Washington published a useful little book under the title "Flora of the Palouse Region," and now they bring out a revision and extension of that work as the "Flora of Southeastern Washington and Adjacent Idaho." In its present form it makes an octavo book of nearly three hundred pages of close, and rather small type. In all 1,139 species are described, and it should be understood that they are *described* and not merely indicated by keys, as is so commonly the case in recent local floras. In fact this is a genuine manual of the systematic botany of a particular region. There is a general key to the families at the beginning of the book, followed by descriptions of the families (with keys to the genera), descriptions of the genera (with keys to the species), and finally good descriptions of the species. The nomenclature is modern and all specific names are decapitalized. It is a most creditable piece of botanical work.

MORE FLORIDA MANUALS

Some time ago (February 27, 1914) we noticed the botanical activity of Dr. J. K. Small in the preparation of manuals of systematic botany, from the ponderous "Flora of the Southeastern United States," to his "Flora of Miami," "Florida Trees" and "Flora of

Lancaster County" (Penn.) and now we must add two more similar books to his credit. They are the "Flora of the Florida Keys" and the "Shrubs of Florida" both of which appeared within the last few months. The first is a neat little volume of about 160 pages containing descriptions of the seed plants growing naturally on the islands of the Florida reef from Virginia Key to Dry Tortugas, a distance of about 225 miles. As the author remarks, "we find here a tropical flora made up almost wholly of West Indian elements, and closely related to the floras of Bermuda, the Bahamas and Cuba." To a northern botanist it seems strange to find among the grasses no species of *Poa,* nor of *Bromus;* in the sedges no species of *Carex;* in *Brassicaceae* but four species; in *Rosaceae* no species; while the leguminous families aggregate 57 species; *Euphorbiaceae,* 45 species; *Malvaceae,* 17 species, and *Rubiaceae,* 22 species. Of the three families of composites there are but 44 species.

In the other little book (of 140 pp.) the northern botanist will be astonished to find a shrubby grass [*Lasiacis* (*Panicum*) *divaricata*], a buckwheat (*Coccolobis*) forming "evergreen shrubs or trees," the Castor-oil plant (*Ricinus communis*) "a small tree or shrub," a shrubby heliotrope (*Heliotropium*), and a low shrubby *Eupatorium.* Both books will well repay careful examination.

SHORT NOTES

AN interesting paper by Dr. W. B. McDougal on "The Mycorhizas of Forest Trees" appeared in the first number of the new *American Journal of Forestry* showing that in some cases the relations between the tree and the fungus is symbiotic and sometimes parasitic.

FREDA M. BACHMANN's paper on "The Origin and Development of the Apothecium in *Collema pulposum*"[1] is a valuable contribution to the theory as to the phylogeny of the Ascomycetes propounded by Dr. E. A. Bessey,[2] in which he suggested that the first Ascomycetes were lichens. In her paper Miss Bachmann says "in the number and nature of its spermatia and in the manner in which they are borne, *Collema pulposum* forms about the most perfect conceivable connecting link between the aquatic red algae with many non-motile male cells which are, however, set free, and such terrestrial ascomycetes as *Pyronema* and the mildews where the male cells are reduced in number to one or two which remain permanently attached."

[1] *Archiv. für Zellforschung,* Band X., Heft 4.
[2] *Mycol. Centralbl.,* Vol. III.

A RECENT handful of papers from Professor Doctor Aven Nelson reminds one of the taxonomic activity of the director of the Rocky Mountain Herbarium at Laramie, Wyoming, and serves to show that there is still much to be done in the systematic botany of the central mountains of the country.

DR. O. E. JENNINGS's "Manual of the Mosses of Western Pennsylvania" (1913) should have been noticed long ago, since it offers to botanists in the central east a descriptive manual of these plants accompanied by fifty-four full-page plates of original drawings. The book includes somewhat more than four hundred pages, and is a credit to the author, and the institution (Carnegie Museum, Pittsburgh) from which it is issued. All told more than 275 species and varieties are described. The treatment is modern, the specific names being decapitalized, and "the rulings of the International Botanical Congress, held in Brussels in 1910, have been followed."

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

CELL PERMEABILITY FOR ACIDS

SINCE Overton's first extensive and well-known studies and his publication of the lipoid theory, interest in the subject of cell permeability has continually increased. Although adherents of the theory have modified and supported it with subsidiary hypotheses the two essentials remain unchanged to-day, namely—(1) that substances which are most soluble in lipoids (fat solvents or fat-like bodies) enter living cells most readily and (2) that they do so because they dissolve in the cell surface which is lipoid in nature.

Opinion concerning the lipoid theory is divided among those who deny the truth of both first and second statements; those who admit the first but not the second and those who accept the theory in its entirety.

The acids form a group of substances of particular interest in this connection in that they are bodies widely different in chemical composition and physical properties—lipoid solubility, degree of dissociation, surface tension—yet the entrance of each into a living cell may be detected by the same method—color change of a suitable indicator within.

It is impossible to stain living cells with dyes which will serve as indicators for acid, as I had previously done for alkalies,[1] so that recourse must be had to organisms with natural indicators. In plants the blue anthocyan pigments of petals are not sensitive enough to weak acids, such as acetic, to warrant their use. In animals despite the number and the variety in color of pigmented forms, indicators are very rare.

Last winter while a member of the Great Barrier Reef Expedition of the Carnegie Institution at Washington, I discovered a Holothurian, *Stichopus ananas*, the "prickly fish" of the Beche de Mer industry, whose viscera contain a purple water-soluble pigment turning red-orange in a concentration of acid between $n/1,000 - n/500$. The chemical composition of the pigment is unknown, but it appears related to the antedonin described by Moseley[2] from crinoids and a deep-sea Holothurian. The purple color is contained in sacs or bodies of unknown nature thickly scattered just under the epithelium covering the various viscera, and is especially abundant in the testes and ovaries, although not in the sperm and egg cells themselves. It is of importance to note that the pigment is contained in or surrounded by living cells and death of the tissue results in a rapid diffusion of the purple from the cells as in the case of so many other pigments. Acid diffusing toward the indicator must therefore pass through the layer of living epithelial cells.

A study of the penetration times of a large

Penetration Rate Tissues of "Prickly Fish" from n/100 Concentration		Toxicity to Cilia of Giant Clam[3]		Strength of Acid Percentage Dissociation at n/128 Conc.		Lipoid Solubility Equivalent Partition Coefficient Xylol/Water		Capillary Activity Surface Tension of n and n/4 Conc. where Water = 7.3 Mg.-Mm.		
¼ min.	Benzoic,	n/2500	Salic.		Nit.*	2.5	Benz.	n	n/4	
	Salicylic,		Benz.	.96–.99	Hydroc.*	1.3	Salic.	?	?	Benz.
	Valeric (iso-),	n/1666	Monoc.		Tric.	0.6	Val.	?	?	Salic.
	Monochloracetic,		Dic.		Sulph.*	0.1	Buty.*		3.56	Val.
2–4 min.	Dichloracetic,	n/1111	For.	.88	Dic.	0.02	Prop.*	3.30	4.39	Buty.*
	Trichloracetic,		Tric.	?	Oxal.*		Monoc.[4]	4.82		Tric.
	Formic,	n/1000	Sulph.*	?	Phos.*	0.015	Dic.[4]	4.82	6.13	Prop.*
	Nitric,		Tart.*	.67	Maleic*		Tric.[4]	5.20		Dic.
	Hydrochloric,	n/909	Val.*	.58	Malon.*	0.005	Maleic*[4]	6.00		Monoc.
9–11	Sulphuric,		Nit.	.35	Monoc.			6.04	6.81	Acet.*
	d-Lactic,		Hydroc.		Fum.				7.07	Malon.*
	l-Lactic,		d-Lac.	.30	Tar.				7.11	Maleic*
	Fumaric,		l-Lac.		Salic.*			6.83	7.14	For.
12–15	Oxalic,	n/833	Fum.		Cit.				7.17	Malic*
	Glycolic,		Glyc.	.20	Malic				7.24	Glyc.
20	Maleic,		Maleic		Form.*			7.19	7.27	Nit.
	Malonic,		Malon.		Glycol.			7.25	7.28	Hydroc.
30	Tartaric,		Malic	.13	d-Lac.			7.27	7.30	Sulph.
	Phosphoric,		Cit.		l-Lac.				7.27	Oxal.
40	Malic,		Acet.	.08	Buty.*			7.27	7.29	Tart.
	Citric,	n/769	Prop.		Val.*				7.27	Cit.
	Acetic,		Buty.	.04	Acet.					
45–60	Propionic,	n/400	Phos.*		Prop.					
	Butyric,				Buty.					

[1] *Jour. Exp. Zool.*, Vol. 10, 1910.

[2] *Quart. Jour. Microscop. Science*, Vol. 17, 1877.

[3] Conc. which just kills in 20 hours.

[4] Insol. in xylol from n/100 conc. in water but slightly sol. from n/10 conc. Remaining acids insol. from n/10 conc. in water.

series of acids, organic and inorganic was made and the results are given in the table on p 948 Pieces of the testis a branched filamentous organ, were placed in a $n/100$ concentration of acid and the time for color change noted. In addition the partition coefficients of the acids between xylol/water was determined as a measure of the lipoid solubility Only a very few acids will pass to xylol from $n/100$ concentration in water and a few more from $n/10$ concentration The strength of the acid (after Ostwald) its effect in lowering the surface tension of water (after J Traube) and its toxicity for cilia (studies of my own carried out in Torres Strait) are also included in the table The acids are ar ranged in order of efficiency in each case Those with nearly the same effect or property are tabulated in groups and in an order to correspond as nearly as possible with the pene tration series An asterisk marks the acids considerably out of place in each series as compared with the penetration series

With the exception of benzoic and salicylic all the acids encounter a resistance—small for some greater for others—at the cell surface If the tissue has previously been killed this resistance is abolished and the cells become readily permeable for all acids The specific permeability of the tissue for each acid is therefore dependent on the living cells

It will be noted that there is no exact quan titative agreement between any two of the series The best agreement is between pene tration rate and toxicity, the worst between penetration rate and degree of dissociation One may conclude that those acids are most toxic which are able to penetrate the cell most rapidly a conclusion supported by my results with alkalies In neither case is there a rela tion between toxicity and dissociation

As regards the lipoid theory my results can not be said to wholly support it neither do they wholly contradict it. The same statement applies to Traube's Haftdruck theory There is a general relation between the power to lower the surface tension of water (capillary activity) and rate of penetration but it is not exact. With acids as with dyes and so many other substances, Overton's theory applies in the majority of cases, but not in all In my opinion this can only mean that the power of penetration of an acid depends on several variable factors One of these is lipoid solubility or capillary activity, for the two run more or less parallel, and a second is the strength or affinity of the acid for certain protein substances of the cell surface This would explain the rather rapid penetration of strong acids little soluble or insoluble in lipoids

E NEWTON HARVEY

PRINCETON N J
April 28, 1914

A DESTRUCTIVE STRAWBERRY DISEASE

MANY of the long distance strawberry shipments of this season have suffered serious injury culminating in a condition designated by the consignees as "molds" or leaks"

In case of mold the berries one or more per box often quite the whole contents of the box, are more or less densely covered with a hairy mold

The term leak' designates a condition in which a liquid issues copiously from the bottom of the box 'Leaks" are accompanied by a soggy condition of the berries which mat down to occupy only one third or one fifth of their original volume

The loss occasioned by these conditions is very large and will in all probability reach well into the millions this season The berries now so affected originate in Louisiana and Mississippi Data are not available concern ing conditions in other states The conditions mentioned have not occurred in previous years to sufficient extent to attract the marked attention of the buyers or inspectors though it is hardly to be supposed that they have been entirely absent

The writer on April 30 acting for the Illi nois Central Railroad, visited the berry region of Louisiana to ascertain the condition the cause and to render any assistance possible.

A preliminary examination at Hammond, La, May 1, of berries which had been in refrigerators over night, which had been picked

about eighteen hours, showed that these berries on an average exhibited two or three per box with very small rotten spots, perhaps 2 to 3 mm. in diameter though only rarely, even under the lens, was any mold apparent.

Visits to the fields showed many berries, green as well as ripe, rotting and molding while still on the vines.

While several types of fungi were present the one which was most characteristic was a *Botrytis*, probably *Botrytis cinerea*.

In the disease history, typically, the rotten spot appears, attains a size of several millimeters. Then a slight surface mold visible under the lens comes over the spot. Later the center of this area becomes coated with the typical *Botrytis* conidia, the whole berry becoming rapidly involved.

In late stages the picture may become complicated by invasion of other fungi, particularly by *Rhizopus nigricans*.

The sorters on the berry farms throw out most of the infected berries and these may be seen, bushels of them, near the sorting benches. Such discarded berries when several days old were almost always covered with *Botrytis* spores and the refuse heap reminded one of an immense culture dish of this fungus, though invariably contaminated by *Rhizopus*.

To ascertain whether apparently sound berries were really infected culture chambers were improvised of jelly jars with the aid of absorbent cotton.

The following tests were made in such dishes:

1. A large number of berries showing incipient decay but with no mold visible under the lens, were cultured. In twenty-four hours every berry showed profuse mold in nearly all cases of the *Botrytis* type; in a few cases other and various types.

2. A large number of apparently healthy berries, fully ripe, but carefully selected were cultured. These at twenty-four and at forty-eight hours showed no mold.

3. A large number of ripe healthy berries were severely jammed, bruised and crushed then cultured. They showed no mold in twenty-four hours.

4. A large number of berries showing various imperfections, sun scald, blister, insect injury, imperfect fertilization but no rotten spots were cultured. No mold appeared.

5. Sound berries were placed half covered with water. No mold appeared in twenty-four hours.

All of the above tests were made at room temperature.

From the practically universal presence of the *Botrytis* on young infected areas and its predominance on the refuse heaps I believe that this fungus is the primary cause of the molding, that the *Botrytis* initiates the decay, opening the way to such other saprophytes as may be present; of such saprophytes, *Rhizopus* is by far the most prominent and most abundant.

Laboratory tests which I have since made show that a berry inoculated with *Rhizopus* will rot rapidly with the escape of a large amount of liquid. It therefore seems probable that the "leaks" are due largely if not entirely to *Rhizopus* invasion.

Both the *Botrytis* and *Rhizopus* have been separated in pure culture in my laboratory and further study of these as well as of the other berry fungi will be made.

In the way of prevention extremely rigid sorting should be emphasized and it would also be well to prevent the refuse heaps from becoming culture beds of the fungus. This can perhaps best be accomplished by liberal use of lime.

F. L. Stevens

Urbana, Illinois,
May 8, 1914

THE AMERICAN CHEMICAL SOCIETY

The forty-ninth general meeting of the American Chemical Society was held at Cincinnati, Ohio, Monday, April 6, to Friday, April 10. The meeting opened with a council meeting on the evening of April 6. Tuesday morning the general meeting of the society was held in the auditorium of the University of Cincinnati and was addressed by the Hon. Frederick S. Spiegel, mayor of Cincinnati, and by President Charles W. Dabney, of the University of Cincinnati, both welcoming the society to the city. President T. W. Richards, of

the American Chemical Society, fittingly responded. The society then held a general meeting, at which the following papers were presented:

"The Chemical Problems of an Active Volcano" (illustrated), by Arthur L. Day.

"The Chemical Fitness of the World for Life," by L. J. Henderson.

"Flame Reactions," by W. D. Bancroft.

"Chemical Reactions at Low Pressures," by Irving Langmuir.

At one o'clock the society adjourned for an excursion to the Filtration Plant of the Cincinnati Water Works, optional excursions being available to the following plants:

Andrews Steel Co., Wiedemann Brewing Co., Old "76" Distilling Co., Frank Tea and Spice Co., Heekin Spice Co., Icy-Hot Bottle Co., Cincinnati's New City Hospital preceded by car ride through suburbs, the Dolly Varden Chocolate Co., W. T. Wagners' Sons Mineral Waters.

In the evening, a complimentary dinner was given to the ladies attending the meeting, followed by a theater party. At eight o'clock, P.M., a complimentary smoker was held at the Hotel Sinton, with 550 members and guests present. Mementos were given to all those attending, and the smoker will long be remembered, especially for the interesting and witty entertainment provided by the local members, and by talent especially engaged for the occasion.

Divisional meetings were held on Wednesday morning and all day Thursday at the University of Cincinnati, at which 181 papers were presented, a special symposium on the teaching of organic chemistry being also held by that division.

Complimentary lunches were furnished on Wednesday and Thursday. On Wednesday afternoon the members were taken through the works of the Globe Soap Company and Proctor and Gamble, with the following optional excursions also offered, W. S. Merrell Chemical Co., Lloyd Library and Museum, Fleischmann Distilling Co., American Diamalt Co., Eagle White Lead Co., National Lead Co., Lunkenheimer Co. Brass Goods, the Zoological Gardens.

On Wednesday evening a symphony concert was given complimentary to the members of the society, and the immense Emery auditorium was filled to hear a concert, under the direction of Ernst Kuhnwald, which has had few superiors in the history of American music.

On Thursday evening, a banquet was enjoyed by the members at the Hotel Sinton, with some 800 present. The banquet was unusual in that especially fine music was furnished by soloists. A decoration particularly worthy of note was an immense American Chemical Society pin in blue and gold flowers.

On Friday a special train complimentary to the members of the society took them and their guests to Dayton to visit the works of the National Cash Register Company, where lunch was served to all of those attending, after which the train proceeded to the works of the American Rolling Mills, at Middletown, and from there to Cincinnati. This day's excursion was particularly enjoyed and the works visited were among the most interesting ever opened to the members of the society.

The meeting closed with the arrival of the members in Cincinnati, and will always be remembered by those present. The members and officers of the Cincinnati section made every effort to insure the comfort and entertainment of their guests, and their hearty good will will never be forgotten by the recipients of their hospitality.

Meetings of all of the divisions of the society, as well as the India Rubber Section and the Water, Sanitation and Sewage Section were held. Details will appear in the published program, as above stated.

The meeting was the largest spring meeting ever held in the history of the society, 658 members and guests being present.

The following are abstracts of the papers presented before the various divisions so far as they could be procured:

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

Floyd W. Robinson, chairman

Glen F. Mason, secretary

Address. FLOYD W. ROBINSON, chairman.

Standards of Food and Drug Chemists: EDWARD GUDEMAN.

The Determination of Mixed Carbohydrates in Infant Foods: T. M. RECTOR AND E. B. WETTENGEL.

In preparations containing mixtures of sucrose, maltose, lactose and dextrine, the sucrose is determined by loss of rotation after inversion with invertase. The dextrine is determined by loss of polarization after precipitation with lead acetate and ammonia. The combined polarization of the sucrose and dextrine is subtracted from the total polarization, giving the polarization of the mal-

tose and lactose. A copper reduction is then run on an aliquot of the solution and the amount of copper reduced by 1 gm. of the sample is calculated. From this value and the combined polarization of the maltose and lactose the percentages of these sugars are calculated by a formula.

The analyses of some commercial infant foods by this method are given.

The Determination of Tannin in Tea: H. C. Fuller.

The powdered tea is first extracted with petroleum ether, which is discarded, and then percolated with 50 per cent. alcohol. The alcoholic solution is precipitated with an excess of lead acetate solution and the whole made up to a definite volume. An aliquot of this is then taken and the excess of lead precipitated with hydrogen in the presence of sodium hydroxide, the lead sulphide being filtered into a tared Gooch, washed and dried over sulphuric acid. A blank is run at the same time and the difference in lead figures is a measure of the lead taken up by the tannin.

A Rapid Method for the Determination of Sodium Chloride in Butter and its Substitutes: T. M. Rector.

The salt is determined by titration with silver nitrate with chromate indicator, in a water solution of a weighed sample of butter in the presence of the butter fat. Some results are given to show that the butter fat does not interfere with the accuracy of the method.

A Rapid Method for the Determination of Unsaponifiable Matter in Fats and Oils: T. M. Rector.

The sample is saponified in the usual manner and the alcoholic soap solution diluted to an alcohol content of 55 per cent. The solution is then extracted with light petroleum spirit, the solvent evaporated, and the residue dried in vacuo and weighed.

Freedom from emulsification is claimed for this method.

The Determination of Caffein in Coffee and Tea: H. C. Fuller.

The sample is ground so that it will pass through a 60-mesh sieve and a weighed amount boiled with dilute hydrochloric acid; the decoction filtered and the extracting process repeated three times with boiling water. From the filtrate the caffein is removed with chloroform, after rendering alkaline with ammonia, and after recovering the solvent the crude caffein is dissolved in acid and precipitated with iodide, and finally recovered from the iodide precipitate by treatment with sulphite and shaking out with chloroform.

The Official Method for Determining Crude-fiber as Applied to Cottonseed Meal: Chas. K. Francis.

The Arsenates of Lead: H. V. Tartar and R. H. Robinson.

Methods have been developed for the preparation of pure lead hydrogen arsenate and lead pyroarsenate. All attempts to prepare lead ortho-arsenate have failed. A new basic lead arsenate has been prepared. The authors believe that lead ortho-arsenate is not a constituent of the ordinary commercial salts used as insecticides. The substance present which has been thought to be the ortho-arsenate is in reality the basic lead arsenate mentioned above. The specific gravity of pure lead hydrogen arsenate is 5.786 and of the basic arsenate is 7.10. Analytical methods have been worked out for the quantitative estimation of lead hydrogen arsenate in the presence of the basic arsenate. This paper will soon be presented in full for publication in the *Journal of the American Chemical Society.*

The Changes Produced by the Wrapping of Bread: H. E. Bishop.

The Determination of Lecithin-phosphorus in Macaroni and Farinaceous Articles: H. C. Fuller.

The macaroni is thoroughly softened with hot water, the mass treated with a large excess of alcohol, the liquid filtered and the solid substance treated with further portions of alcohol; the combined alcoholic solutions are evaporated and the residue extracted with ether, which dissolves the lecithin. Phosphoric acid is determined in the latter by ignition of calcium acetate and finishing in the usual way with ammonium molybdate and magnesium mixture.

Lobster Oil: H. S. Bailey and L. B. Burnett.

In the cooking of lobsters preparatory to canning there is always a layer of oil collected upon the top of the kettles. For a number of years it has been the custom of the packers to skim off this oil and sell it to the dealers in fish oil who doubtless mixed it in with their low-grade products. Through the kindness of Dr. W. D. Bigelow we were able last year to obtain a sample of this lobster oil. It is a bright orange red in color and has a characteristic fishy odor and taste. A search of the literature failed to reveal any mention of this oil, although König[1] states that the

[1] *Chem. Nahr-u-Genussm.*, Vol. II., p. 498.

fresh German lobster contains about 1 84 per cent. of oil.

An analysis of this particular sample gave the following results

Specific gravity, 25°/25°	0 9255
Refractive index, 25°	1 4765
Iodine number	145
Saponification number	175
Soluble acids (as butyric)	0 65%
Saturated (solid) acids	10 5%
Unsaturated (liquid) acids	80%
Insoluble acids	88%
Acetyl value	16 9
Iodine number of unsaturated acids	160
Iodine number of saturated acids	1 5
Melting point (capillary tube) of solid acids	51 6° C
Molecular wt of unsaturated acids	315
Saponification number of acetylated fat	184

Tomato Seed Oil H S BAILEY AND L B BURNETT

The rapidly increasing production of tomato pulp and catsup in the United States and the fact that oil is already being made on a commercial scale from the waste tomato seeds in Italy, make an investigation of the composition of this oil very desirable Last season a few pounds of tomato seeds were obtained, and pressed in an expeller of the continuous action type The oil thus obtained refined and bleached easily and was apparently a satisfactory food oil.

The Digestibility of Corn Consumed by Swine S C GUERNSEY

Digestion trials to compare the digestibility of maize in the natural state, with that of the shelled and ground grain, the latter two forms being fed both dry and soaked, were conducted in 1909 with 10 heavy weight swine, weighing about 200 pounds, in 1910 with the same number of light weight animals weighing about 70 pounds and in 1911 with 10 light weight and ten heavy weight hogs Each year the different forms of maize were fed through four ten day periods to the swine, which were kept in cages, five animals being fed at a time, each receiving one form of corn through a ten day period The apparent digestibility was determined by weighing and analyzing the feed and corresponding feces, the latter being collected in rubber bags attached to the animals by a harness. A charcoal marker was fed at the beginning and end of each period for identification of the corresponding feces. The light weight swine digested whole grain on cob, and shelled grain more thoroughly than did the heavy weights, while the latter utilized the soaked ground grain to better advantage than did the former With the light swine, the whole grain on cob has the highest digestion coefficient, then dry shelled, dry ground soaked shelled and soaked ground grain while with the heavy weights the soaked ground grain has the highest digestibility then dry ground dry shelled ear and soaked shelled corn A remarkable correlation between digestibility and time required for digestion was found in the series of experiments conducted in 1909–10 brought to notice by observations on the interval between the feeding of bone black and its appearance in the feces In a general way, the higher the coefficient of digestion, the longer the time required for the feces to pass through the alimentary canal and *vice versa*, which holds true with both classes of swine as a whole or as separate classes

Chemical Changes Occurring During the Period of Silage Formation RAY E NEIDIG

The investigation included studies of the principal chemical changes which occurred in three silos built of different materials The period covered was the first three weeks after filling the silos The rate of increase or decrease of the following substances was determined daily volatile acids, non volatile acids soluble carbohydrates and alcohol Daily analyses were made of the gases of the silos and temperatures were taken by means of electric thermometers buried in different parts of the silos The results show that sucrose is hydrolyzed to invert sugar in the early stages of fermentation and then a very gradual loss in carbohydrates is noted The soluble carbohydrates do not disappear entirely, however, and those remaining were identified as invert sugar Along with the gradual diminishing of the carbohydrates there is a uniform rise in acidity, both volatile and non volatile acids are formed, the latter predominating The volatile acid consists mainly of acetic acid together with some propionic acid, the non volatile acid is the inactive or racemic variety of lactic acid. Alcohol was found in small quantities in all silos in slightly varying amounts The gas analysis showed a rapid production of carbon dioxide after filling the silos, reaching the maximum during the first few days and then gradually decreasing Oxygen, on the other hand, was found only in traces after the first three days. The temperatures were quite uniform in all silos, the maximum temperature observed being 32 8° Centigrade.

Preliminary Notes on the Curing of Cucumber Pickles H N RILEY

The activities manifest in a curing tank of cucumber pickles seem all to depend upon the growth of certain bacteria, known as "lactic acid bacteria." These seem to govern the rate of fermentation, or giving off of gas, and the production of acid The rate of fermentation mechanically governs the rate of absorption of salt, which is also influenced, to some extent, by the size of the pickle The growth of mold and yeast seems destructive as they destroy the acid which is the principal keeping factor in the brine.

A Rapid Graphic Method for Calculating Rations and Dietaries D L RANDALL

The different common foods were classified according to the weight of protein in a hundred calorie portion and were arranged graphically on cards so that the distance taken up by any quantity of a food is the same as that which represents the protein as plotted to a definite scale By suitable manipulation of these cards one can determine the quantity of different foods in combination necessary to get a definite amount of protein and energy and can determine the composition of any mixture of foods, all this being done with no other calculation than the addition of simple whole numbers usually less than ten

The Hydrolysis under Pressure, of Sugar Solutions W S HUBBARD AND W L MITCHELL

Notes on the Determination of Total Sulfur PHILIP L BLUMENTHAL

Barium in Various Plants NICHOLAS KNIGHT AND LESTER W RUSK

The leaves and stems of thirteen different plants and common trees have been examined and barium has been found in all of them Twenty five grams of the leaf or stem have been taken for each determination The investigation will be extended to include plants from widely different localities

The Non uniformity of Drying Oven Temperatures LORIN H BAILEY

Tests on eight different types of drying ovens, including those heated by gas, electricity, hot water and steam, showed that only those ovens which are surrounded by boiling water and steam, or by steam alone, maintain uniform temperatures Other ovens show maximum variations of from 15° C to 24° C throughout the drying chambers, and a range from 2° to 17° C from the temperature indicated by thermometer inserted through the top of oven and ordinarily taken as the temperature at which the drying is done. It is the type rather than the price that makes a good oven

The Analysis of Alkali Soils C N CATLIN.

The determination of "alkali," in soil, is one of the most important analyses the agricultural chemist in semi arid countries is called upon to make, but there are no standard methods for the determination The author has collected and made a comparative study of many of the methods now in use. The results in several cases were not even comparable the percentage of water soluble solids by some methods amounting to several times that found by others Chlorides corresponded approximately The chief source of difference lies in the completeness of solution of sodium carbonate and of calcium sulphate neither of which is dissolved easily and completely from the soil The highest results were obtained by the method in use at the Arizona Agricultural Experiment Station. This consists in digesting 50 grams of soil with 800 to 100 c c of water for ten hours on the boiling bath whereby a constant and complete extraction of water soluble salts is secured Aside from the difference due to completeness of extraction, large discrepancies were found in determining sodium carbonate

Dates Comparative Cost of, in Akron, Ohio CHAS P FOX

The Composition of Gooseberries, with Special Reference to their Pectin Content E H. S BAILEY

Some preliminary analyses have been made upon a variety of wild spiny gooseberries that grow abundantly through northern latitudes The interior of the half ripened berry, the condition best suited to jelly making, consists of a firm, hard glistening mass, with but few seeds In order to obtain the juice it is necessary to boil the crushed berries repeatedly with water On a large scale the berries yield 9 88 per cent of insoluble material, including skins, seeds and short stems

A preliminary analysis of the berries gives

	Per Cent
Dry solids	19 42
Ash	87
Ash, soluble in water	87
Ash, insoluble in water	33
Proteins	1 37
Acid (as acetic)	1 27

Since pectins are precipitated by mineral salts, the question is raised to what extent the use of

hard water in the making of jellies reduces the pectin content. Experiments in this line are being conducted. A bibliography of recent work is appended.

A Rapid Method for Commercial Analysis for Marls and Limestones: O. B. WINTER.

The commercial value of marls and limestones used for agricultural purposes depends largely upon their content of calcium and magnesium in the form of carbonates. Two methods are given for estimating lime—one, precipitating the calcium oxalate in the presence of oxalic acid, and the other, in the presence of hydrochloric acid. The carbon dioxide is determined by treating the sample with a small volume of hydrochloric acid and measuring the gas evolved. Results show that this method for carbon dioxide compares favorably with several other methods when certain precautions are used.

The magnesium is determined by calculating the amount necessary to combine with the carbon dioxide not taken up by the lime.

A Method for the Estimation of Calcium, Strontium and Magnesium in the Presence of Phosphoric Acid and Iron: O. B. WINTER.

Calcium and strontium are precipitated as the oxalates in a dilute hydrochloric acid solution. The oxalates are burned to the oxides, weighed and then nitrated and the nitrates weighed. The amounts of each (calcium and strontium) are determined as follows: (1) By separating the nitrates with absolute alcohol and ether. (2) By calculation from the amounts of oxides and nitrates. The magnesium is determined as magnesium pyrophosphate in the filtrate from the oxalates, by removing the ammonium salts and silica, and keeping the iron in solution by means of sodium acetate.

The Chemistry of the Decomposition of Peat and Muck: C. S. ROBINSON.

Some Pot Experiments with Mixtures with Peat and Manure in Connection with Various Fertilizers: C. S. ROBINSON.

BIOLOGICAL CHEMISTRY DIVISION

Carl L. Alsberg, chairman

I. K. Phelps, secretary

Coagulation of Albumen by Electrolytes: WILDER D. BANCROFT.

Colloidal Swelling and Hydrogen Ion Concentration: L. J. HENDERSON, W. W. PALMER AND L. H. NEWBURGH.

The Functions of Ammonium and Phosphoric Acid in the Regulatory Excretion of Acid: L. J. HENDERSON AND W. W. PALMER.

Partition of the Nitrogen of Plant, Yeast and Meat Extracts: F. C. COOK.

There is great variation in the precipitating power of the different reagents compared. Phosphotungstic acid precipitated the highest, tannin salt reagent the next highest and acid alcohol the lowest percentage of the nitrogen of the seven plant, five meat and one yeast extracts examined. The formol titrated method gave lower results for amino nitrogen than the Van Slyke method. All of the methods showed a larger percentage of the nitrogen present in a more completely hydrolyzed state in the plant than in the other extracts. No kreatinin and very little purin nitrogen was found in the plant extracts. The yeast extract was high in purin nitrogen, but contained no kreatin or kreatinin. The nitrogen of the plant extracts was found in the filtrate from the acid alcohol reagent. Twenty five per cent. of the nitrogen of the other extracts was precipitated by this reagent. The plant extracts showed more ammonia by the Folin method than the other extracts.

Comparison of the Various Methods for the Quantitative Determination of Sugar in Blood: MAX KAHN. (By title.)

Clinical Studies of the Russo Test: MAX KAHN. (By title.)

Urinary Catalase in Health and Disease: MAX KAHN AND C. J. BRIM. (By title.)

On the Presence of Oleic Acid in Gastric Contents of Patients Suffering with Gastric Carcinoma: MAX KAHN AND J. SUBKIS. (By title.)

The Lipins of Diseased Human Livers: J. ROSENBLOOM. (By title.)

The Potassium Content of Cerebrospinal Fluid in Various Diseases: J. ROSENBLOOM AND V. L. ANDREWS. (By title.)

A Standard in the Determination of Ammonia by Nesslerizing with the Duboscq Colorimeter: A. R. ROSE AND KATHERINE R. COLEMAN. (By title.)

Nephelometry in the Study of Nucleases: P. A. KOBER.

A Soluble Polysaccharide in Lower Fungi: A. W. DOX.

The Chemical Dynamics of Living Protoplasm: W. J. V. OSTERHOUT.

The Physiological Water Requirement and the Growth of Plants in Glycocoll Solutions Alfred Dachnowski and A Gormley

Though it is not known precisely to what extent amino acids occur in peat soils the question of the ability of plants to utilize directly nitrogenous compounds in the soil other than nitrates and ammonia is of considerable importance The data presented show that the absorption of glycocoll is not connected with the transpirational water loss, but with the efficiency of the nutritive metabolism characteristic of the plant, and with the amount of water retained within the plant and involved in metabolism Changes in body weight, if taken as the measure of growth, may be pronouncedly altered by the quantity of the metabolically retained water as well as by the deposition or removal of reserve materials in the tissues The failure to promote continuous growth may be due to the inefficiency of glycocoll to supply material for tissue construction This and the lack of available water enforce compensating processes in the plant The apparently inevitable conclusion is entertained that the problem of the water requirement of plants and the criteria for the wilting coefficient, in particular the relation between the water content of the plant and that of the soil at the time of wilting, need to be reinvestigated more quantitatively than has heretofore been attempted The retention of water, not transpiration, is the physiological function correlated with and indispensable to growth in general, and to survival and greater areal distribution of plants entering physically or physiologically arid habits (To appear in *Amer Jour of Botany* Vol I April, 1914)

The Estimation of Amino Acids as Such in the Soil R. S Potter and R S Snyder.

Methods Adapted for the Determination of Decomposition in Eggs and in other Protein Products H W Houghton and F C Weber

The methods that were found most applicable for the determination of decomposition are the Folin titration and Nesslerization methods for free ammonia, Klein s modification of Van Slyke s method for amino nitrogen and Folin Wentworth method for acidity of fat Calculating the results on liquid eggs to a moisture-fat free basis, the following amounts of ammonia nitrogen in milligrams per 100 grams of material were obtained By the Folin titration method, seconds gave, 11 4, spots 14 1, light rots, 17 3, rots, 26 2, black rots, 169 6, by the Folin nesslerization method, seconds gave 12 4 spots, 20 0, light rots, 21 5, rots, 29 9, black rots, 148 6 The amino nitrogen determination is of service in detecting liquid and dried blood rings, spots and light rots. The increase in the acidity of the fat detects spots and worse grades of eggs. The ammonia methods applied to herring give results indicating decomposition of the fish after standing 24 hours at about 70° F Applied to clams, an appreciable increase in the ammonia is shown after keeping two days at a temperature of 60° F to 65° F.

Factors Influencing the Quality of American Sardines F C Weber and H W Houghton.

This paper embodies some of the results of the observations and studies conducted at the laboratory established by the bureau of chemistry of the Department of Agriculture at Eastport, Maine, during the season of 1913 It does not refer to the packing of sardines in California. The chief factors responsible for the lack of uniform quality in oil and mustard sardines packed on the eastern coast are Excessive pickling and salting, which removes a large amount of protein material (amino compounds), and lack of attention in securing a uniform degree of salting Use of fish containing undigested food, particularly "red feed" which is the principal cause of broken and damaged fish The steaming process, which removes a great deal of salt and flavor from the fish Insufficient drying of the fish before packing, causing in the finished product a milky appearance of the oil a slight soapy taste and the fish to be too soft Variations in the composition of the fish at different times of the year and from different localities particularly in regard to the fat content Quantity and quality of oil used. Freezing and thawing of the packed goods Considering all the possibilities, in connection with this industry, the most important of which is the packing for quality rather than quantity, as is done at present, it is believed that sardines can be produced in this country that are in every respect as good as the foreign sardines

The Composition and Nutritive Value of the Proprietary Infant Foods F C Weber and F C Cook

Chemical, bacteriological and microchemical examinations were made of 36 proprietary infant foods The nitrogenous constituents were separated and analyses were made of the water extracts and of the ash. The foods, prepared according to the manufacturers' directions for a three month formula, were analyzed Charts based on the analyses of the foods and on the three month formulæ were prepared and the foods classified according to their composition and method of prepara

tion for feeding. The results of feeding the three-month mixtures to rats, mice and kittens, and the nutritive value and ratios of these mixtures, were tabulated. The chemical deficiencies and abnormal nutritive ratios in some of the foods are confirmed by the results of the animal feeding tests. Foods prepared with milk and water give uniformly better results than those prepared with water alone. A comparative study on puppies of the value of lactose and maltose was made.

The Electrical Stimulation of Tissue: OLIVER E. CLOSSON.

In using standardized inductorium for the faradic stimulation of tissue by the break induced shock it was found that the point in the primary circuit where the break is made and the distribution and nature of the resistance must be the same as used in standardizing. Keeping the same resistance in the primary circuit so that the open circuit potential difference and amperage remain unaltered, the position of the secondary in the region 50 cm. from the primary may be made to vary as much as 15 cm. for the same stimulating value by changing the point in the primary circuit where the current is broken or by changing the distribution of the resistance. In the secondary circuit the distribution of the electrical capacity is of very great importance in determining the beta unit of Martin. It is found that the stimulating value is greatest when the distribution of the capacity is such as to produce the greatest fall in the average absolute negative potential (electron potential) of the kathode and anode. The irritability was greatest with an anelectrotonic change, just the opposite to the usual electrotonic findings. It, however, conforms with the findings which point to the kations as being the important factor in stimulation.

A New Apparatus for Determining Crude Fiber in Foods, Feeding-stuffs and Feces: A. D. EMMETT.

In crude fiber determinations, it is often very difficult to transfer the last portion of the insoluble residue from the flask to the Gooch crucible or funnel. The use of the beaker is an advantage, not only from the standpoint of accuracy, but also with respect to the saving of time. The special feature of this apparatus is the arrangement which makes it possible to use a beaker. It consists of a specially constructed glass cone and rubber ring which prevents appreciable loss of water vapor during the boiling and thereby any increase in the concentration of the acid and alkali solutions. The inverted cone is attached to a Hopkins condenser with rubber tubing and the ring is snapped on to the lower edge of the cone. The condenser, cone and ring are then lowered over a 400 c.c. *lipless* beaker and adjusted until the connection between the rubber ring and beaker is tight. The entire apparatus is fastened in place by the clamp which holds the condenser. The glass cone is provided with a side tube attachment which is so constructed that when air is drawn through the apparatus gently, the tendency to foam is greatly retarded.

The Carbon Dioxide Excretion as Modified by Body Weight: G. O. HIGLEY.

This work was done with the apparatus described in "The Carbon Dioxide Excretion Resulting from Bicycling," Higley and Bowen, *American Journal of Physiology*, XII, 4, page 311 (1904). There were nineteen subjects, students in the University of Michigan. The subjects, who had been engaged in laboratory work for several hours preceding the experiments, reclined for fifteen minutes preceding the putting on of the mask and the beginning of the record. The average excretion of carbon dioxide per kilogram of body weight was .0063 grams. Wide departures from this value seemed to be due (1) to an excessive amount of adipose tissue in the body of the subject giving *low* results, and (2) to colds and indigestion giving high results.

Proteins of the Central Nervous System: H. H. MCGREGOR AND C. G. MACARTHUR.

A study of the proteins of the central nervous system has been conducted by drying the fresh tissue with an air current and removing a large proportion of the lipoids by cold solvents. After this treatment the solubility of the protein in aqueous solutions is found to be greatly increased, and the product precipitated by addition of excess of alcohol contains only slight amounts of lipoids. The protein obtained by this method contains phosphorus and has always given a slight though definite reaction for iron. Whether extracted by distilled water or by salt solutions, the protein is not precipitated upon dilution: the extract therefore contains no true globulin. Treatment with weak acetic acid yields an acid-precipitated and an acid-soluble fraction. The evidence from fractional heat coagulation and fractional salting out points to the individuality of the protein, instead of the presence of a mixture of nucleoprotein and globulin.

Enzymes of the Central Nervous System: H. M. ENGLISH AND C. G. MACARTHUR.

...ade directly from fresh ...e dilute alkalies, dilute and glycerine ... several days' standing toluol or oil of mustard as a preservative, the ... were examined Lipase, peptase, nuclease, ...nase, peroxidase, arbutinase, salolase, dex...ase, were found to be present. Lipase gave activity on the following substances in the following order Triacetin, monobutyrin, ethyl butyrate, olive oil, kefalin, lecithin Sodium glycocholate, saponin sodium phosphate, were activators for lipase The various divisions of the brain contained the same enzymes, but in different amounts The cerebrum extract was several times as active as that of the medulla Gray matter is much more active than white matter

Specificity in the Action of Drugs on Brain and Heart Fosfatids C C MACARTHUR AND G H CALDWELL

If caffein, cocain, strychnin and other brain drugs show their specificity by some particular effect on brain kefalin and brain lecithin, these drugs ought to change the very sensitive calcium chloride precipitation limit of the fosfatid solution Many series of determinations gave no such result Digitalis strofanthin (etc) should effect heart lecithin and heart cuorin solutions in a similar way No consistent results of this kind were noticed These results suggest that the fosfatids, in the condition isolated, are not concerned either through their solubilities, through changes in the state of aggregation or through chemical combination in drug action Probably these drugs effect more complex combinations or more labile groups of substances than those we isolate

Reduction Processes in Plant and Soil M X SULLIVAN

Plant roots possess the power to reduce ammonium molybdate to the blue oxide MO_2O_5 and to reduce a mixture of para nitroso dimethyl aniline and alpha naphthol to naphthol blue The first reduction is favored by a slightly acid medium and occurs predominantly within the parenchyme cells just back of the root tip It is probably due to nonenzymotic products The second reduction is not particularly localized, and is retarded by dilute acids, favored by dilute alkalies Certain solids likewise have the power to form naphthol blue from the mixture of para nitroso dimethyl aniline and alpha naphthol Soils possessing this power do not oxidize easily oxidizable substances such as aloin Conversely, as far as investigated, soils acting on aloin do not form naphthol blue

The Passage of Nucleic Acid from Plant to Medium M X SULLIVAN

In the water in which wheat had grown for sixteen days, with change of water every two days, material was found which was soluble in dilute alkali, precipitated by dilute acids and alcohol, contained phosphorus, gave the pentose reactions and on hydrolysis with dilute acid gave a reducing sugar and xanthine bases such as guanine, determined by color reaction and formation of the hydrochloride and adenine, determined by color reaction The material was judged to be nucleic acid

Chemical Studies upon the Genus Zygadenus C L ALSBERG

A number of species of plants of the genus *Zygadenus* are regarded as poisonous Great confusion from the toxicological standpoint has existed in this genus because the nomenclature of this genus has not always been clearly understood Thus the alkaloids of the "veratrine" group have been misnamed It is not found at all from species of the genus *Veratrum* *Veratrum* contains no veratrine, but as is now well known, is a mixture of quite different alkaloids The alkaloids of the "veratrine" group are, as is generally known, obtained from sabodilla seeds. These are the seeds of a species of *Zygadenus* Hunt was the first to show that the *Zygadenus Venenosus* of the western United States contains the same or similar alkaloids Slade confirmed this and Heyl and his collaborators obtained a crystalline alkaloid, apparently belonging to this group, from *Z intermedius* In the investigation herein reported, similar alkaloids were obtained in crystalline form from *Z Venenosus*, *Z elegans* and *Z coloradensis*, all of them very toxic and with similar pharmacological action From a member of a closely related genus, *Amianthium muscætoxicum*, a similar active principle was obtained in an impure state Apparently many of the species of this group of lilies contain "veratrine" alkaloids or alkaloids related to it

Nephelometry in the Study of Nucleases PHILIP ADOLPH KOBER AND SARA S GRAVES

The nephelometer can be used for the study of nucleases, if an acid egg albumin solution is used as a precipitant This reagent will reveal the presence of one part of yeast nuclei acid in 1,000,000 parts of water, and in practical work is not affected by most substances found in physiological work

CHARLES L. PARSONS,
Secretary

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